Popular Science

MONTHLY Founded 1872

May
1929
25 cents

New Ideas: Aviation - Ra[illegible] - Automobiles - Home Building
[illegible]ineering [illegible] and The Home Workshop

TOOLS that you are proud to own... that are a joy to use

The Plumb Scout Axe—pronounced "Official" by The Boy Scouts of America. Axe alone, $1.40; with leather sheath, $1.80.

Peter McLaren, Champion Chopper, has used Plumb Axes exclusively for more than twenty years. He says: "The keen edge, the tapered blade, and the balance of a Plumb save me one minute in a five-minute chop."

Here is the test of a nail hammer,—drawing a headless nail. The hardened nipper claws of a Plumb will grip and pull the finest headless brad, not once,—but every time. H. F. 81 model, price $1.50.

The razor-keen edge of a Plumb Hatchet "bites in"; cuts fast and accurately; saves your strength; gets work done. No. 2962, $1.60.

They come to you with the approval of skilled mechanics, champions and experts everywhere

In the carpenter shop, on the building job, in machine shop and garage, in the woods and on the farm,—everywhere, men who demand *the most* of a tool use Plumb.

The Champion Chopper of America, whose reputation rests upon the blade of his axe, uses only Plumb. The Boy Scouts of America adopted the Plumb as the *Official* Scout Axe. Skilled craftsmen select the Plumb Nail Hammer, the Ball Pein, the Hatchet.

Experts, champions, mechanics: It takes more than mere tempering and forging and shaping a handle to win their approval.

And Plumb gives more: A tool that is scientifically designed for its particular job; a tool that is balanced till it works like a part of your arm; hatchets and axes of specially selected steel, hardened and tempered to hold a *shaving* edge.

Nail hammers that drive a nail accurately or draw the slimmest, headless brad; ball peins that add power to your blows . . . or that you can control on finer work.

Every tool equipped with that exclusive Plumb patent—the Take-Up Wedge which tightens a handle, when it loosens, just by a turn of the screw.

Finished with rust-proof Black Head and stain-proof Red Handle—ready for a lifetime of service.

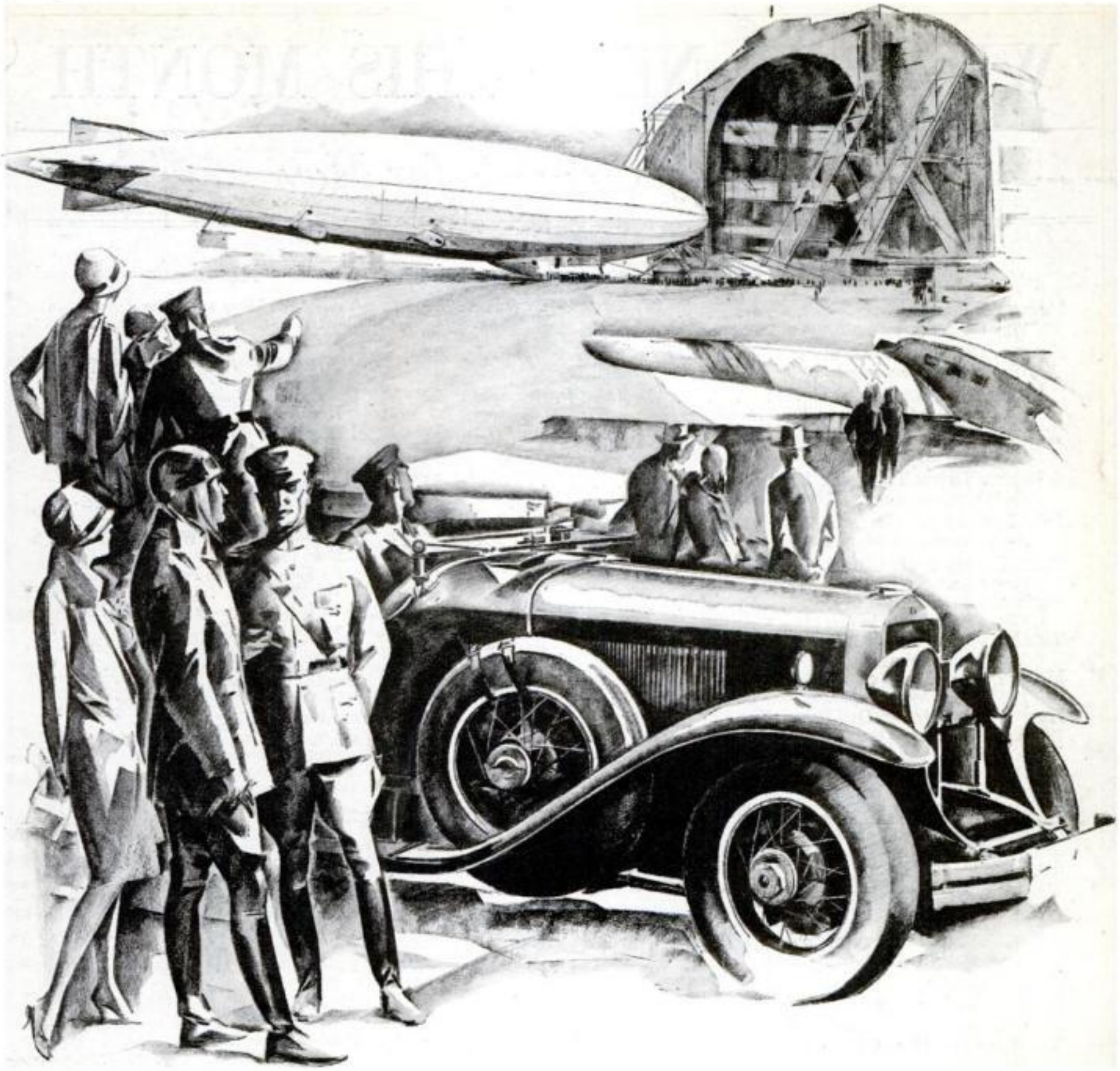
It is the *extra* value that won leadership for Plumb,—those added touches in a tool that make it a joy to use.

Your hardware merchant is a tool expert. Get his advice about the Plumb Tools best fitted for your work.

Fayette R. Plumb, Inc., Phila., U.S.A.

PLUMB
DOUBLE LIFE
Hammers Hatchets
Files Sledges Axes

For peining the smallest rivet, or striking the hardest blow, the balance of a Plumb Ball Pein controls your stroke. H.F. 375, 1½ lb. model, $1.30. Other models in proportion. All prices slightly higher in Far West and Canada.



WHAT IS NEW THIS MONTH

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May, 1929, Vol. 114, No. 5. **Popular Science Monthly** is published monthly at 250 Fourth Avenue, New York, N. Y., by the Popular Science Publishing Co., Inc. Entered as second-class matter Dec. 28, 1918, at the Post Office at New York under the act of March 3, 1879; additional entry as second-class matter at Chicago, Illinois. Entered as second-class matter at the Post Office Department, Canada. Printed in U. S. A. Copyright, 1929, by the Popular Science Publishing Co., Inc. Single copy, 25 cents. Yearly subscriptions to United States, its possessions, and Canada, $2.50; foreign countries, $3. In presenting in its editorial columns numerous stories of new products of applied science, **Popular Science Monthly** does not underwrite the business methods of the individuals or concerns producing them. The use of **Popular Science Monthly** articles for stock-selling schemes is never authorized. O. B. Capen, President and Treasurer; R. C. Wilson, Vice-President; A. L. Cole, Secretary.

Exceptional People

Health and Hygiene

Laboratory Discoveries

Nature

New Devices for the Home

New Processes and Inventions

Photography

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Unusual Facts and Ideas

For the Home Owner

Hints for the Mechanic

Ideas for the Handy Man

Good INVESTMENTS Can Be *Misfits*

By WALLACE AMES, *Financial Editor*

For thirty-five years Amos Trevor had been with the firm, rising from a minor clerical position to a post of considerable importance and responsibility. Thirty-five years continuously on the job . . . except for the orthodox two-weeks' vacation each August . . . so when Amos Trevor reached his sixtieth birthday he decided that the world owed him a permanent vacation.

And why not? Amos Trevor was a widower. One by one his three children had married and settled in homes of their own. His two sons were well-established in business and his daughter was the wife of a prominent young physician. Amos was free of financial responsibilities, except to provide for himself. For this purpose he had the income from $100,000 which he had accumulated during his business life. So Amos Trevor retired.

* * *

Amos Trevor, Jr., the older son, had chosen a life insurance career, at which he was very successful. He was studious and had come to be regarded as one of the best informed life insurance men in the city. He was conscientious and enjoyed the reputation of considering the interests of his clients first. He had a likable personality; people enjoyed doing business with him; his contacts were of the best. He was aggressive, but not objectionably so. He was making friends and making money; he was a success.

* * *

Robert Trevor, the younger son, had also engaged in a professional career—advertising. After serving an apprenticeship in one of the larger agencies he had gone into business for himself. At first he obtained a few small accounts, did most of the work himself, had a small overhead, did not require much capital, and was showing a snug profit each year.

The accounts served by Robert Trevor were growing. Their merchandising plans were sound, their advertising well planned, and they were benefiting from the prolonged era of prosperity. With just the accounts that Robert now had it was evident that his business would grow and that his capital requirements would increase. For a small, newly organized agency, Trevor, Inc. enjoyed a fine reputation. His work had gained considerable attention and opportunities to increase his list of accounts were beginning to occur. All signs pointed to a large advertising business, requiring considerable capital. But just at present Robert Trevor was making more money than he needed for family expenses and to run his business, so he, too, was investing in securities.

Note the situation of the three Trevors. Amos, Sr. retired, with no outside financial responsibilities; with ten, fifteen or more good years ahead of him. He had accumulated comfortable financial means. In planning his investments his chief need was *income*. He had no income except from his investments. To participate in life's comforts his aim was to obtain the maximum income, safely, from securities. His children were doing well, there was no need to increase his wealth so as to leave a greater inheritance for them.

Amos, Jr. was in a line of business that would never require much capital. Already he had a considerable income in renewal commissions; he was writing a larger volume of insurance each year; the most productive years of his business life were immediately ahead. He was not dependent upon income from his investments—in fact, he was reinvesting all of it, as well as a portion of his commission income. In planning his investments, Amos, Jr. was in a position to seek *increase of principal* so that in later years he would have the greatest obtainable sum on which to retire.

Robert Trevor was confronted with a different problem than either his father's or brother's. The capital requirements of his business might increase at any time—on a moment's notice. And a call for more capital meant an opportunity to make more money. He should be ready when the call came. In planning his investments, Robert's chief need was *availability*.

* * *

Amos Trevor's sixtieth birthday, the day of his retirement, was an occasion on which the family got together. Naturally the subject of investments was the chief topic of conversation.

"How have you invested your money, dad?" inquired Amos, Jr.

"I have distributed it over a list of nearly thirty common stocks," was the reply.

"Common stocks!" exclaimed Junior, with some surprise.

"Not the kind you are thinking of," his father assured him. "In the first place, I have spread the risk, with only about $3,000 invested in the stock of any one company. In the second place, I have selected only the soundest of companies in which to make my investments. They are all on a dividend basis and all of them are earning much more than they are paying out in dividends. Stocks of companies I have selected should advance materially in market value during the next few years. Their dividend yield hardly averages 5% on the price I paid, but I stand to increase my principal materially."

(Continued on page 5)

Good Investments Can Be Misfits

(Continued from page 4)

"Spreading the risk, as you say, is a sound plan. My insurance experience has taught me that," said Amos, Jr. "But my contact with the management of insurance companies has taught me more. It has taught me that gilt-edged bonds are the best investment. If a security isn't good enough for the insurance company it isn't good enough for me. That has been my motto from the time I made my first investment. True, my bonds have not increased materially in value. And their income yield is small, compared to what some people tell me they get on their investments. But my money is safe and the safety of several thousands of dollars is far more important than a few dollars more or less of income. Furthermore, there is always a ready market for my bonds, at close to what I paid for them. They may not go up so high as your common stocks, but neither will they decline drastically in value. I am playing just as safe as I know how, which I am sure will pay out best in the long run."

"You are right and you are wrong," broke in Robert Trevor, who had some ideas himself on good and bad investments. "With all due respect for dad's greater experience, I am like you, Junior, old-fashioned enough to prefer conservative bonds to speculative stocks. But from what you say I suspect I am getting considerably more income from my investments than you, and my investments are safe, too. What is your average return on your bonds?"

"Slightly under 5%," answered Amos, Jr.

"Well, I'm getting nearly 6% and if you take the trouble to look over my list I think you will agree that every security on it is safe."

Robert made a list of securities he held. It included several public utility, industrial and foreign bonds of a class that an investment banker would loosely class as second grade. They were good bonds, but for one reason or another not up to insurance company requirements. They offered a reasonable degree of safety, but were not gilt-edged security. A few preferred stocks on the list were subject to the same description. Naturally, Robert's investments paid a higher income return than Junior's.

"What's the market in these securities of yours, Robert?" asked Junior. "I suspect there is a wide difference between the bid and the asked price on most or all of them. If you wanted to sell quickly I'll bet you might have to take a loss, and on some of your holdings you probably couldn't get an immediate bid at all. What will your bank loan you on these securities? The amount you can borrow on them is one reliable test on how good your investments are.

"Now I can borrow 80% of the face value of my securities any time and I can sell out just as quickly as I give the orders. Both you and father would do better if you would put your money in such gilt-edged bonds that I have."

* * *

The arguments (Continued on page 6)

ADVICE *to* HUSBANDS

whose wives are careless about money

By a Husband

I OFTEN wonder if my wife understands the value of money. When she goes shopping, she usually comes back without a cent.

I am not complaining — far from it. Helen is a wonderful wife and a wonderful housekeeper. But frankly, I don't believe she realizes how fast the dollars slip through her fingers.

I often thought, "What would become of us if we didn't get a little farther ahead financially? And what on earth would become of Helen and the children if anything ever happened to me?"

One day I told my worries to a friend. He listened carefully — asked questions. Then *he* began to talk.

How to end money worries

"Frank," he said, "you don't want to pay rent all your life. You hope to own your own home some day. And you want to quit work sometime, don't you?"

I nodded.

"Then do this. Write to the Phoenix Mutual in Hartford and ask them to send you a copy of a little book they have. It's called 'How to Get the Things You Want' and it tells how you can get rid of a lot of those money worries that are bothering you."

I followed my friend's advice. In a day or two I received a copy of one of the most interesting little books I have ever read. It explained how I could end my biggest money worries by simply rearranging my financial life slightly.

It described a plan, recently perfected by financial experts—a plan which would enable me to insure a comfortable future for myself and family.

It also showed me that our financial trouble was not due to *my wife's* carelessness. It was due to *my own* ignorance of a few simple financial rules.

Send for the facts

This story is typical. The book, "How to Get the Things You Want," tells how you can become financially independent—how you can provide an income to retire on—how you can do many other things which you may have felt were beyond the reach of your income.

The plan it describes is backed by one of the oldest, most conservative institutions in this country. The minute you read about it you will realize why it works. No obligation. Send for your copy of the free book now.

FREE BUDGET BOOK

If you request it in the coupon below, you will receive without cost a valuable 32-page Budget Book called "The Business of Running a Home." This Budget Book furnishes you with convenient blanks for keeping a simple record of your major expenses and for planning your expenditures in advance. It will also enable you to determine:

How much rent you can safely pay
How to live within your income
How to avoid common difficulties in budgeting
How to itemize your expenses
How to cut down expenses
How to spend wisely
How to tighten up financial leaks
How much you should save—and other valuable information

Several thousand copies of this Budget Book have been sold for 25c a copy. But now, as a special offer, readers of this magazine may obtain a free copy by mailing the coupon below.

PHOENIX MUTUAL LIFE INSURANCE COMPANY
Home Office: Hartford, Conn. First Policy issued 1851

PHOENIX MUTUAL LIFE INSURANCE CO., 431 Elm St., Hartford, Conn.

Send me by mail, without obligation, the booklet or booklets I have checked

☐ "How to Get the Things You Want." ☐ Budget Book.

Name_____ Date of Birth_____

Business Address_____ City_____

Home Address_____ State_____

ADVICE IN BUILDING

Popular Science Institute Tells How to Cut 30% Off Your Fuel Bill by Insulating

An insulated house is warm in winter, cool in summer and costs one-quarter to one-third less to heat than a similar house without insulation.

Before you build or modernize your present home, you will want to have information on insulation. A 24-page booklet, INSULATION IN BUILDING CONSTRUCTION, gives actual facts and figures as to what insulation will accomplish, tells where it is of greatest value, describes the principal insulating materials and shows particular methods of application.

The Engineers of The Institute have prepared this booklet which contains data secured from thousands of architects and builders, as well as University laboratories and Government bureaus. Price 25 cents. Popular Science Institute, 248 Fourth Ave., New York, N. Y.

Good Investments Can Be Misfits

(Continued from page 5)

of Amos, Jr. sounded convincing. Robert was convincing, too. So was their father. All three had given considerable thought to their investment plans; all of them had reasoned out their preferences. But all three were wrong in their conclusions. Each had invested in securities poorly suited to his particular requirements.

Amos, Sr. needed income; he invested for future increase in principal. Amos, Jr. should have invested for principal gain; he had invested for marketability and super safety. Robert's situation was such that he ought to have invested in liquid, marketable securities; he had invested for safety and income at the expense of marketability. This, in turn, suggests two rules to follow: 1. Establish your connections with some reputable investment banking firm and be guided by their advice. 2. Familiarize your investment banker with your circumstances to guide him in giving you advice.

To Help You Get Ahead

THE Booklets listed below will help every family in laying out a financial plan. They will be sent on request.

"How to Build an Independent Income" is the title of a new booklet by the F. H. Smith Company which explains conclusively how people of moderate means may obtain financial prosperity. **"55 Years of Investment Service"** describes the history of progress of the F. H. Smith Company as well as making an attractive suggestion in first mortgage real estate bonds. May be obtained by addressing the home office of The F. H. Smith Company, Smith Building, Washington, D. C.

The House Behind the Bonds reminds the investor of the importance, not only of studying the investment, but of checking up the banker who offers it. Address: Fidelity Bond & Mortgage Co., 1188 New York Life Building, Chicago, Ill.

"The Investment Trust from the Investor's Viewpoint," presents an explanation of this form of investment in easily understood terms, illustrated with some interesting examples of how the general investment trust will help the man with $100 or more to get ahead. Published for free distribution by United States Fiscal Corporation, 50 Broadway, New York. Ask them for Booklet IT.

How to Retire in Fifteen Years is the story of a safe, sure and definite method of establishing an estate and building an independent income which will support you the rest of your life on the basis of your present living budget. Write for the booklet to Cochran & McCluer Company, 46 North Dearborn St., Chicago, Ill.

How to Get the Things You Want tells how you can *use* insurance as an active part of your program for getting ahead financially. Phoenix Mutual Life Insurance Company, 328 Elm Street, Hartford, Conn., will send you this booklet on request.

The Guaranteed Way to Financial Independence tells how a definite monthly savings plan will bring you financial independence. Write for this booklet to Investors Syndicate, 100 North Seventh Street, Minneapolis, Minn.

The Making of a Good Investment tells how 6½% can be made on investment in First Mortgage Bonds in units of $50, $100, $250, $500 and $1000; how the bonds are protected and how simple it is to purchase them. For a copy of this booklet address United States Mortgage Bond Company, Limited, Detroit, Michigan.

Dandruff disappears so quickly

SOONER or later, everyone experiences the annoyance and humiliation of a case of dandruff. Contact with others, promiscuous use of towels, combs and brushes, the trying on of hats, spread this common ailment.

When this dandruff appears don't let it become serious. At the first sign of it, use full strength Listerine. It has remedied this condition for thousands.

The treatment consists of dousing Listerine, full strength, on the scalp and massaging vigorously, repeating the treatment frequently for several days. This is important.

From the outset you will be conscious of a marvelously cool, clean and healthy sensation of the scalp, and within a few days, you will note that dandruff is disappearing.

Dandruff is a germ condition, and noted dermatologists declare that the successful method of combating it is by frequent massage and applications of antiseptic.

Full strength Listerine, as you know, is not only a safe antiseptic with a tendency to soothe and heal tissue, but is also one of great germicidal power.

Laboratory tests show that it destroys 200,000,000 of the virulent Staphylococcus Aureus (pus) and Bacillus Typhosus (typhoid) germs in 15 seconds. We would not make this statement unless we were prepared to prove it to the entire satisfaction of the U. S. Government and the medical profession. Lambert Pharmacal Company, St. Louis, Mo., U. S. A.

LISTERINE

The Safe and Soothing Antiseptic

kills 200,000,000 germs in 15 seconds

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Guaranteed Advertisements

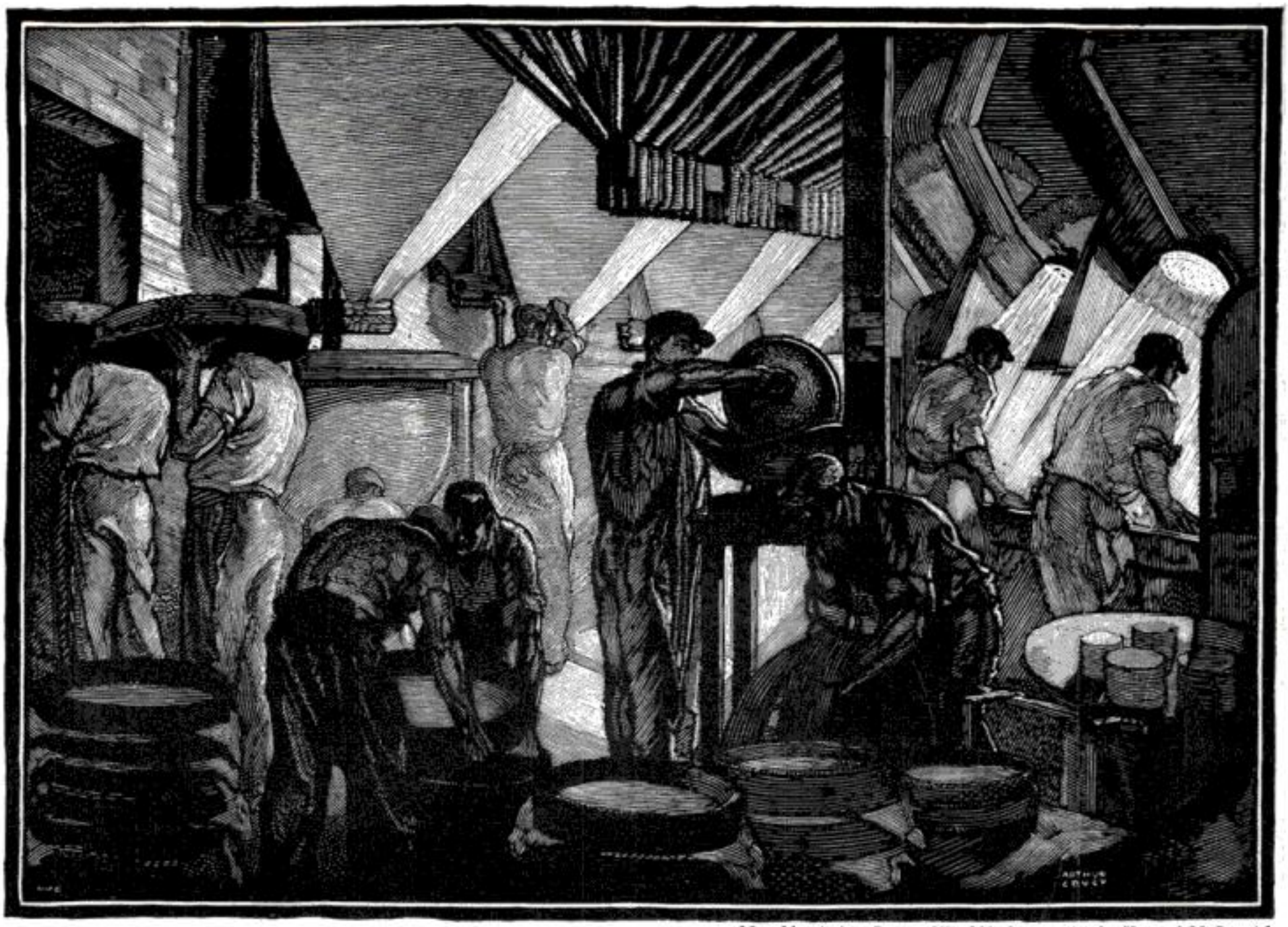
Popular Science GUARANTEE

POPULAR SCIENCE MONTHLY guarantees every article of merchandise advertised in its columns. Readers who buy products advertised in POPULAR SCIENCE MONTHLY may expect them to give absolute satisfaction under normal and proper use.

Tools, Radio Apparatus, Oil Burners and Refrigerators advertised in POPULAR SCIENCE MONTHLY have been tested or investigated by the Popular Science Institute of Standards and each advertisement carries the insignia indicating approval.

However, other products advertised in the magazine not subject to test carry the same guarantee to readers as products tested.

THE PUBLISHERS



Mural by Arthur Covey. Wood block engraving by Howard McCormick

TO the master of mural painting, this panel in Norton Hall is "a portrayal of the spirit of the men who labor in the process of producing grinding wheels." To the shop man, however, it is merely "a mixing room." Here, with knowledge gained by long experience and scientific formulae, are mixed these master tools—grinding wheels.

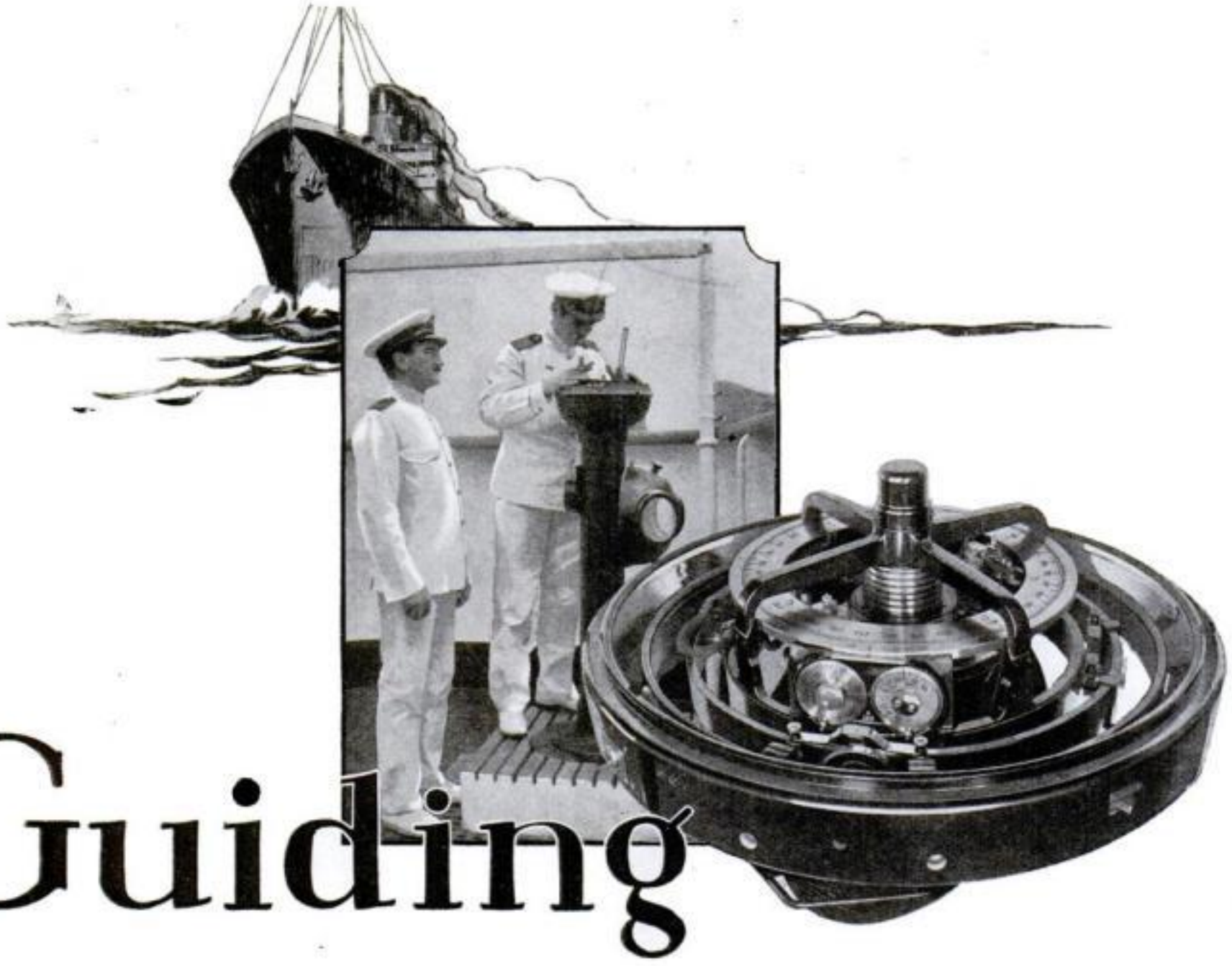
Today, when the metal worker employs a grinding wheel, he uses not the crude, carelessly formed natural grindstone, but a definite tool, manufactured with the same care as a fine gauge; a tool that increases production, reduces costs, minimizes friction and adds safety as well as long life to our modern mechanisms.

Precision and rapid production make exacting demands upon the producers of grinding wheels. The world's requirements cannot be met by a single abrasive nor by one process. And to meet these innumerable requirements, scientists pioneered the way in world-wide quests for the proper substances, and with the aid of the electric furnace made these native materials of the most service to man.

Yesterday, the machinist ordered a "grinding wheel." Today, he specifies his grinding operation. He demands a wheel that will give him the most perfect cutting action on the metal to be worked, or under whatever conditions may exist. And, in the making of his wheel, scientific consideration will be given to the size and form of the abrasive grain, the proper bonding, the shape, the diameter and size of the wheel—all based upon the particular work at hand, the speed at which the wheel is to be operated, and the speed of work when it is revolving.

To meet the world's need for this great variety, thousands of formulae are evolved from practical experiences of technical men in laboratories and engineers afield.

NORTON COMPANY, WORCESTER, MASS.



Guiding great ships across trackless oceans —with the help of SKF Bearings

THE day of the centuries-old magnetic compass that guided Columbus to a new world, is going the way of the towering sails that he unfurled to the four winds.

And in its place has arisen a new mechanical marvel that depends not upon the attraction of that mysterious spot on the chart that is known as Magnetic North, but upon wheels revolving at terrific speeds in a miracle-working product of science that points to True North always.

And the Sperry Gyroscope Company, knowing full well the necessity for bearings that could be counted upon to stand up under all conditions of service, has selected for this newest and greatest aid to navigation

"The highest priced bearing in the world."

SKF INDUSTRIES, INCORPORATED
40 East 34th Street, New York, N. Y.

SKF
Ball and Roller Bearings

A Sperry Gyro Wheel that revolves at 8600 R.P.M. In a test conducted by the Sperry Gyroscope Co., SKF Bearings were in operation 24 hours a day for 747 days, a total of 8,734,848,000 revolutions — the longest continuous bearing run on record.

YOU MAY BUY A BEARING AS A BARGAIN BUT TRY AND GET A BARGAIN OUT OF USING IT
for
Nothing is apt to cost so much as a bearing that cost so little

SKF Puts the Right Bearing in the Right Place

2223

Sound can be controlled anywhere

Modern science makes it possible to regulate sound, but only Johns-Manville has experience sufficient to cope with every problem of excessive noise or poor acoustics

"Reduced noise by two-thirds" writes Edward E. Brown, vice-president of the First National Bank of Chicago, after installation of Johns-Manville Office-quieting Treatment.

For years Johns-Manville Acoustical Treatment has been used to provide correct acoustics in theatres, churches, and other auditoriums.

EXCESSIVE noise, or poor acoustics, is due to uncontrolled sound. For years we have studied sound, have invented devices for measuring, or even photographing this invisible force, and have perfected means of harnessing it. As a result, J-M acoustical engineers are the only group of men in this country, working commercially, who have any complete, comprehensive understanding of sound control.

Noise is costly in business establishments, is annoying everywhere. To tolerate noise has now become old fashioned. The Johns-Manville method of sound-quieting and acoustical control is neither experimental nor theoretical. It will often eliminate as much as 80%.

How J-M Halts Sound Waves

The control of sound may be for the purpose of preventing disturbing noise, or it may be concerned with the correction of acoustics, as in auditoriums or other public rooms.

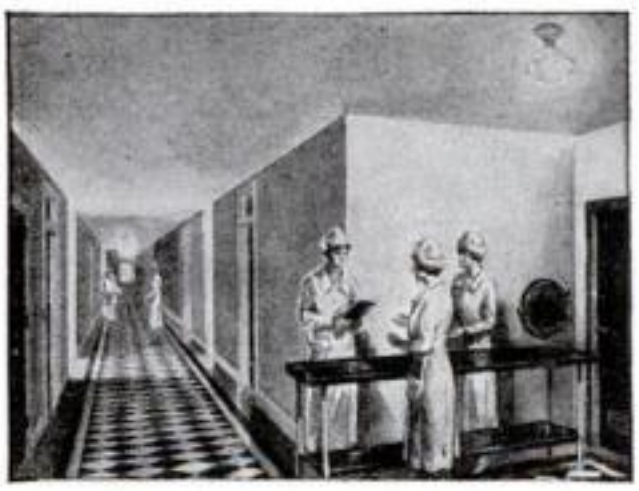
The plaster, cement, glass, and sheet metal so common in present day construction have almost no ability to absorb sound. A sound wave, even though invisible, will bounce about a room as literally as a rubber ball might. The result is that irritating and disturbing confusion of sound which we generally describe as noise.

Decorative Schemes Unaffected

Johns-Manville acoustical experts, by the use of special finishes, produce a surface which will absorb as much as 80% of the sound in a room, and do so without affecting the architectural or decorative scheme.

In your own office, or factory, in your church or lodge room, in a hospital in which you are interested, anywhere, in fact, Johns-Manville can banish excessive noise and bring about an amazing degree of quietness and calm.

Industrial buyers and home owners the country over know Johns-Manville Asbestos products such as Asbestos Shingles and Built-up Roofing, Heat and Cold Insulations, Packings, Brake Linings, and scores of other products. Yet in none of these is there more careful effort than in the really marvelous science of sound control.



The ceiling of this corridor at the Harper Hospital, Detroit, Mich. (Albert Kahn, Architect) blots out disturbing sounds because it is covered with Johns-Manville Sound Control Material which silences reverberations and echoes.

This picture is a photograph of sound. By such Johns-Manville methods are auditoriums analyzed in order to determine where and what acoustical treatment is desirable. Our own photographing devices make it possible to take pictures showing the movement of sound waves at their origin, and during the bounding and interference which results in noise.

Johns-Manville

SOUND-ABSORBING TREATMENT

JOHNS-MANVILLE CORPORATION
New York, Chicago, Cleveland, San Francisco, Toronto
(Branches in all large cities)
Please send me information about the Johns-Manville Method of Scientific Sound Control.

*Name*_____

*Company*_____

*Address*_____

AC-96-5

The Facts on House Insulation

Expert Advice Now Made Available to Every Home Builder

By
COLLINS P. BLISS
Director of The Popular Science Institute of Standards

Insulation pays its way by cutting down the annual fuel bill from twenty to forty percent. And it assures comfortable temperature.

"I'M PUTTING insulation in my new house. I don't know much about it, but my architect has convinced me that it's too good a thing to pass up."

It is a safe guess that, when it came to putting a furnace or electricity in his home, nobody had to convince this man that it was the thing to do. But, had it not been for an up-to-date and insistent architect, he would have overlooked one of the best modern aids to home comfort. Insulation is one of the few real conveniences that are permanent and have no upkeep cost. It pays actual dividends in fuel-saving that soon offset its initial cost.

Insulation Pays Its Way

TO MOST people, house insulation is a vague something that never has had to be used before and need not be used now. Most people know what their dollars invested in an automobile or radio bring, but they have only the haziest idea of what insulation accomplishes. If they knew that, dollar for dollar, insulation pays its way in saving fuel bills, providing a cozy, warm house in winter, a cool house in summer, and uniform room temperature, they would soon include insulation among the prime essentials.

Insulation itself is nothing new. Its principles have been applied since earliest times. But the effective and economical insulating materials now designed for house construction have been available only within the last few years. Nobody talks about "putting on insulation" when he dons a fur coat or pulls up a woollen blanket, but that is what he is doing. Insulating means stopping heat flow. Fur and wool, with their fibrous texture full of air spaces, are insulators in that they present a barrier through which heat has a hard time traveling. Cotton, silk, and linen, on the other hand, contain few air spaces, and heat can travel quickly through considerable thicknesses of such materials. The body is not able to generate enough heat to keep up with the rapid loss through these materials; therefore they fail to keep one warm.

Brings Real Comfort

BIRDS and animals do not have to worry about insulation for nature has supplied them with it, but man has always had to work out schemes for keeping himself warm. He solved the problem of body insulation ages ago, but it took many centuries to evolve a method for preventing heat leakage in his home. Primitive men, with their tents of animal skins or mud huts, as well as our grandfathers with their stone walls some sixteen inches thick, were all working to cut down heat loss. They did not get very far. But in the twentieth century, real home comfort has been achieved. Today the home builder need only apply a half inch or so of one of the effective modern insulating materials in roof and walls to make his house a home instead of a mere shelter.

In planning house insulation, the home builder may consult an able architect or an experienced contractor. They may offer valuable suggestions, but it is up to him to make the decisions. It is a wise builder who takes all the professional suggestions he can get, and yet supplements such information by finding out for himself exactly what the market has to offer, what is most advantageous for his use, and just what the actual returns on the investment are likely to be.

The Institute Finds Out

TO HELP the home builder who wants all the facts on insulation, Popular Science Institute recently undertook a nation-wide survey of the subject. First, it consulted 5,000 architects and builders in all parts of the country, obtaining their opinions on insulation in general, their preferences with regard to special materials, and their experience as to the most desirable methods of application. Then The Institute secured from every manufacturer of insulating material, university laboratory, and Government bureau all the data that they had on the subject. The vast amount of information thus gathered was studied and organized by the engineers of the Popular Science Institute. Facts were checked, inaccuracies determined, and finally all the data put into printed form in a way to give the home builder specific, non-technical advice.

The result is a twenty-four-page booklet "Insulation in Building Construction," which gives actual facts and figures as to what insulation will accomplish, tells when and where insulation is of most value, describes the principal insulating materials, and shows particular methods of application. A section of this booklet is devoted to the actual use of insulation in houses already built, and tells just how to go about insulating such buildings as well as the correct time to insulate effectively and economically. Another part of the booklet tells about air leakage and its remedies, as distinct from heat leakage which insulation corrects.

The price of the booklet is twenty-five cents. In writing for it or in sending special questions on insulation and other building problems, address Popular Science Institute, 250 Fourth Ave., New York, N. Y.

INSTITUTE BULLETINS
and
SERVICE AIDS FOR READERS

Insulating the Home*
List of Approved Tools
List of Approved Radio Products
What the Radio Buyer Should Know*
Current Radio Questions Discussed
List of Approved Oil Heating Devices
Advice on Installing Oil Heat
List of Approved Refrigerators
Refrigeration for the Home*

*Price 25c each

Romance or reality, movie studios or factories ...*there* this *grainless* wood

In moving picture studios the strength and lightness of Masonite Presdwood, combined with its ability to take any finish, make it the chosen material for set building. In industry the same qualities lower production costs and make manufactured articles better. Perhaps you, too, can use it to advantage. May we send you samples to try?

FOR SCENES IN THE MOVIES

A king's palace today—a rustic cottage tomorrow. To Masonite Presdwood, as used in the leading movie studios, it is all in the day's work, for so sturdy is this beautiful grainless wood that moving picture producers find they can use the same pieces again and again—in scene after scene.

But this versatile actor, Presdwood, plays equally important industrial roles. Today a shipment goes to an automobile body plant to be used in motor truck side panels. Tomorrow a carload is routed to another factory where children's toys are being turned out by the thousand. In fact, there seems to be no limit to the wide range of uses for this attractive paneling material. And alert production managers are continually finding new ways to use it in improving their products or lowering the cost of the articles they manufacture.

Unlimited Uses in Industry and Building

Presdwood is used for the ceilings of railway passenger coaches, for the backs of theatre seats, in automobile bodies and speed boat decks and hulls. It makes light, strong, splinterless shipping containers, decorative folding screens, bass and snare drum shells, table tops, kitchen cabinets and many other familiar objects.

FOR PUNCH PRESS OPERATIONS

In building, it is used for interior paneling, for house and office partitions and for the lining of closets, attics or elevator shafts. It is specified for the surfacing of concrete and masonry forms. And because it is easily sawed or cut and does not split, it is ideal for the man at home who puts up shelving or for the mechanic who builds a doll house.

Eliminates Waste and Expense

Since it is free from knots, checks, or cracks, Masonite Presdwood reduces waste and cuts expense to a minimum. And because it is made from natural wood, with no artificial binding material, it cannot possibly harm valuable tools and machinery.

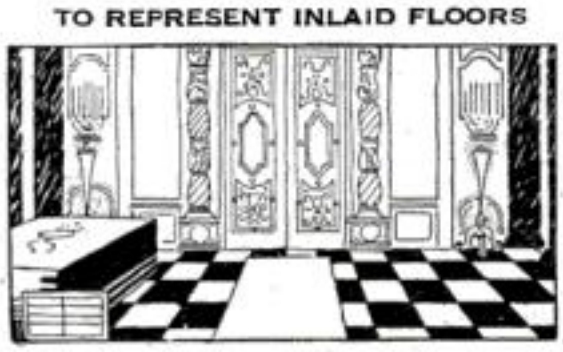
New methods and up-to-the-minute materials will bring profits to your business. Masonite Presdwood is wood in its most modern form.

Investigate its money saving possibilities. Your request will bring a generous free sample by return mail.

MASONITE CORPORATION
Sales Offices: Dept. 725 111 W. Washington St.
Chicago, Illinois

Mills: Laurel, Mississippi

TO REPRESENT INLAID FLOORS



Masonite PRESDWOOD

Made by the makers of
MASONITE STRUCTURAL INSULATION
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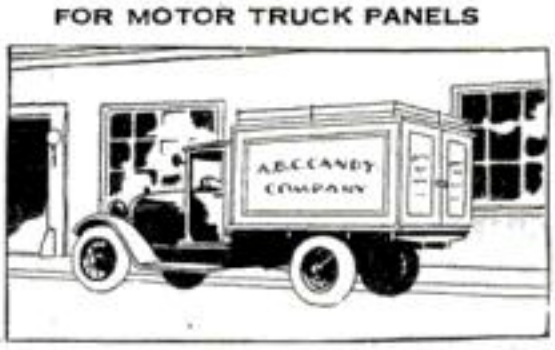
FOR MOTOR TRUCK PANELS



Our Readers Say—

Etc., Etc.

"DON'T take too much notice of the growlers whose complaints you publish. They have got bugs, etc."—C. S., Dunedin, New Zealand.

Otherwise, a Masterpiece!

"WE WISH to make a few comments on cover design of your February issue of POPULAR SCIENCE.

"We note the very cleanly dressed iron-worker who is apparently unhooking the chain from the column that we imagine has just been set. Where do you find an iron-worker that has as clean a shirt as this fellow has on?

"If he had to shin the column to loosen the chain why did he climb above the chain to loosen it, and if it was necessary for him to assume the position in which you show him in the picture, what will happen to him when the chain is loosened? His right foot is resting on the chain, and from all appearances when the chain is loosened his right hand will be the only means of support he will have.

"He appears to have quite a lot of slack in his hand. If there was that much slack in the chain why was it necessary for him to climb the column to loosen it? The method of slipping a chain is very simple—it is very seldom that they stick. You merely slack off on the load line and the chain slides down the column. The hook that he is trying to unloosen is also hooked the wrong way on the chain.

"We also note that each beam connection has eight rivets holding it to the column. If eight rivets were necessary at the column why not eight rivets in the beam, the load being equally divided at this point?

"We also notice that the tag line, which is laying on top of the ball, was evidently not used in erecting the column or this snarl would have been taken out of it before the load started up.

"Trusting that these comments will not be offensive."—R. R. C., Pittsburgh, Pa.

Queensberry Rules?

"LET me register skepticism as to one detail in Scotty Allan's exciting dog article. This is where the author subdues a vicious dog with his *bare* hands, ascribing to the animal a human sense of fair play which would have been outraged if Mr. Allan had used gloves, brass knuckles, or club. It seems to me that any method of a knockout that entailed no painful after effect, followed by the kind treatment described by Mr. Allan in his story, would have served the purpose."—J. R. M., Little Falls, N. J.

Voices from the Shop

"IT IS my opinion that the Home Workshop Department should be distinctly separate from your other departments, so distinctly that it will be in a class by itself. Also, it should be enlarged for greater effectiveness, as the 'home workshop' is gaining every day in popularity, owing to the great development of small machinery of all kinds."—W. C. L., Downers Grove, Ill.

"I have constructed many articles from directions in the Home Workshop. I find them very easy to understand and the articles exceedingly practical and attractive."—Lieut. E. T. P., Culver, Ind.

"I am sending a picture of twenty model Lindbergh planes constructed from your Blueprint No. 67 in one of my manual training classes. The Lindbergh model creates more enthusiasm than any problem I have ever tried. I heartily recommend it to all manual training teachers who desire a live, interesting, and thoroughly instructive project."—F. D. L., Proctor, Vt.

"I have built four models from your airplane plans and all have been very good flyers. I built six of the *Spirit of St. Louis* and sold them for $30 each."—E. W. B., Dorchester, Mass.

"I want to thank Mr. W. Clyde Lamkey for the thorough way in which he tells how to set up a bench saw. It couldn't be done better."—W. F. W., Cherokee, Ill.

It Sank Home

"JUST to let you know that I have now joined the select few who understand Einstein.

"Upon reading Mr. Armagnac's article, I informed my wife that, after all, she was only a shadow of the real thing.

"Whereupon I discovered that gravity not only is an acceleration, but a very simple mechanical process."—R. L., Ph.D., Bismarck, N. D.

Atta Boy!

"IN THE article 'If You Had Millions to Spend,' the last part of the sixth paragraph says about the flying laboratory: 'the day when all the world will be on wings.'

"This day will not come, because a more important flying machine will make its appearance—a machine without wings. This is the helicopter. I have made some drawings of helicopters. Not one of them resembles helicopters of the present type. It seems to me the helicopter is more simple to invent than the airplane was. The only matter with the helicopters of the present day is that they upset, but they can easily be made so they will balance.

"So I do not think that the airplane will rule the air in the future, for in a few years the helicopter will take its place. I will get it out if no one else can!"—P. T., St. Paul, Alberta, Can.

Well, Why Not?

"I NOTICED a short editorial on the shortcomings of modern railroading. Being a traveling man I can contribute a lot more data on that subject, particularly in the territory within a couple of hundred miles of Philadelphia.

"I am forced to use a car, as are most salesmen these days. The reason lies in a simple statement—with the exception of three runs out of Philadelphia my car can make better time than any railroad.

"Now what I can't understand is this. If an auto can travel the highways, through traffic, around turns, stopping for signal lights, and without signals, as fast as a loco on rails, how much faster time could the auto make if it were put on rails?

"There has been some talk of railroads running bus lines over the highways for short hauls. Why do they want to encroach upon the already crowded highways, sacrificing safety and speed, when they already have perfect, high-speed highways?

"The Pennsylvania Railroad is talking aviation. They know this is experimental and will be so for ten years. In the meantime more and more salesmen are taking to the highways, and will soon be lost to common carriers forever. And yet the railroads could so easily and cheaply retrieve a portion of that lost passenger business by running buses on their present rails. Why not?"—W. R. C., Germantown, Pa.

Maybe Einstein Helped

"I THINK a journal like POPULAR SCIENCE MONTHLY should publish nothing but proved facts, or else give it as ideas, theories, or of that nature.

"In the article on guano birds it states that these birds, on one island alone, eat one thousand tons of fish a day. What I wish to know is who counts or weighs the fish they eat?

"In the same issue it gives a history of John Kenlon's works. What I want to know is, if he saw the last vestige of his ship sink, how and where they got ropes to frame their cement boat? Also sails sufficient to sail that boat 1,600 miles in sixteen days?

"Well, I may want some other explanations again some time, so I reckon this is enough for this time."—F. C. C. C., P. M., Flint, Tex.

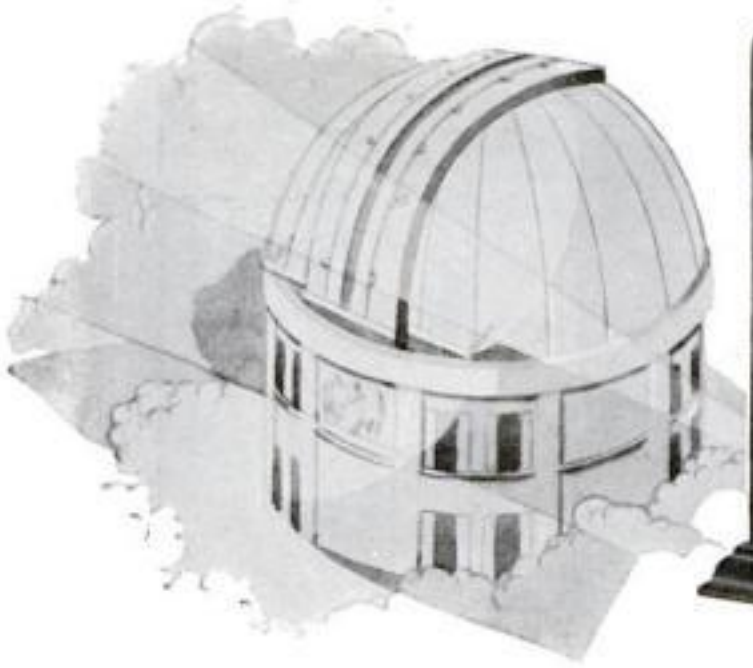
From the First Skywriter

"APROPOS of your recent article on 'Skywriting' and your reference to me as the first skywriter in the world—

"The first writing for the *Daily Mail*, of which you told, was a very nervous experience, as it meant all our future. This also applied to the first writing in America, and as the word I wrote was 'Hello U. S. A.,' it would have been rather disastrous if the smoke had stopped working after the first four letters!

"The only other occasion I had 'nerves' was the day I was married in Los Angeles, when I was called upon to skywrite 100 miles away and was afraid a forced landing might prevent me from getting back. Incidentally, although that was six years ago, I am still very glad I did *not* have a forced landing."—Capt. Cyril Turner, Boulogne, Seine, France.

HAMMOND ELECTRIC CLOCK



Colonial "A" Model

This is a very popular model of the new Hammond electric clock that tells off Naval Observatory time and operates from the light socket. Size 6" high, 5" wide. Solid walnut case. It's just the thing for the home or the executive's office desk. Other models for home or office are described in circular sent on request.

$14.50

*Your Local Light Company is now Sending Naval Observatory Time to Your Home

Your Light Company now supplies a time service which enables you to secure U.S. Naval Observatory time from any light socket in your home without special wires.

The current coming to your home over the light wires is known as alternating current. It is further identified by voltage, usually 110, and by cycles per second, usually 60. The Power Company can control both voltage and the number of cycles per second.

The mechanism in the Hammond Clock counts the cycles per second entirely independent of the voltage. Fluctuations in voltage do not affect its operation. The speed at which it rotates is determined entirely by the number of cycles per second of the current that passes through the field coil.

The Light Company accurately controls the number of cycles per second of the current so that any Hammond Clock operating on their lines will tell off U.S. Naval Observatory time. So accurately does the Light Company regulate the frequency that your Hammond Clock can never vary more than a few seconds. The central station checks their master clock with Naval Observatory time at frequent intervals.

The Hammond Clock of course contains no springs, no mechanical escapement and it never has to be wound. It should not be confused with so-called electric clocks which are merely electrically wound.

The time service which your Light Company furnishes is free. The current consumed by the clock costs but a few cents a month. If you live in or near a large city, in all probability this time service is available in your home. The Hammond Synchronous Clock makes it possible for you to take advantage of this time service to secure U. S. Naval Observatory time.

Send the coupon below for free descriptive circulars on the modern way to tell time.

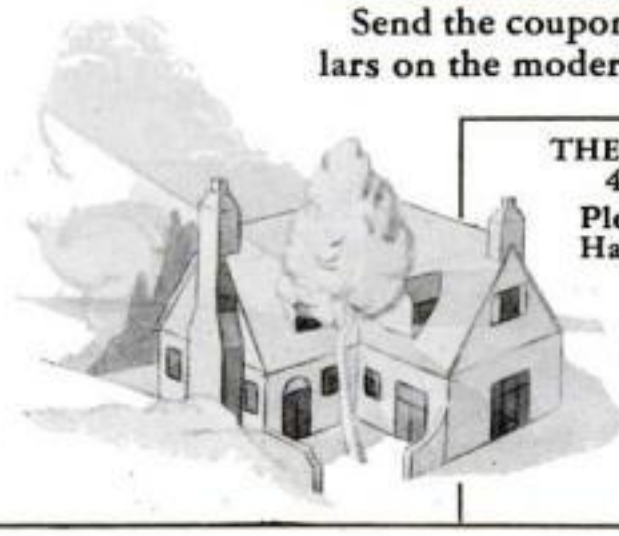
* *Some of the smaller Light Companies as yet do not supply time service. (Regulated frequency.) Practically all of the large Power Companies do, but if in doubt, ask your dealer or write us.*

Gothic Mantel Model

A beautiful Hammond Clock 12" high, 9¾" wide. Walnut case with silver finish dial. Price $29.50

Wall model 10" diameter face for stores and offices. Price $22.50

THE HAMMOND CLOCK COMPANY
4115 Ravenswood Avenue, Chicago



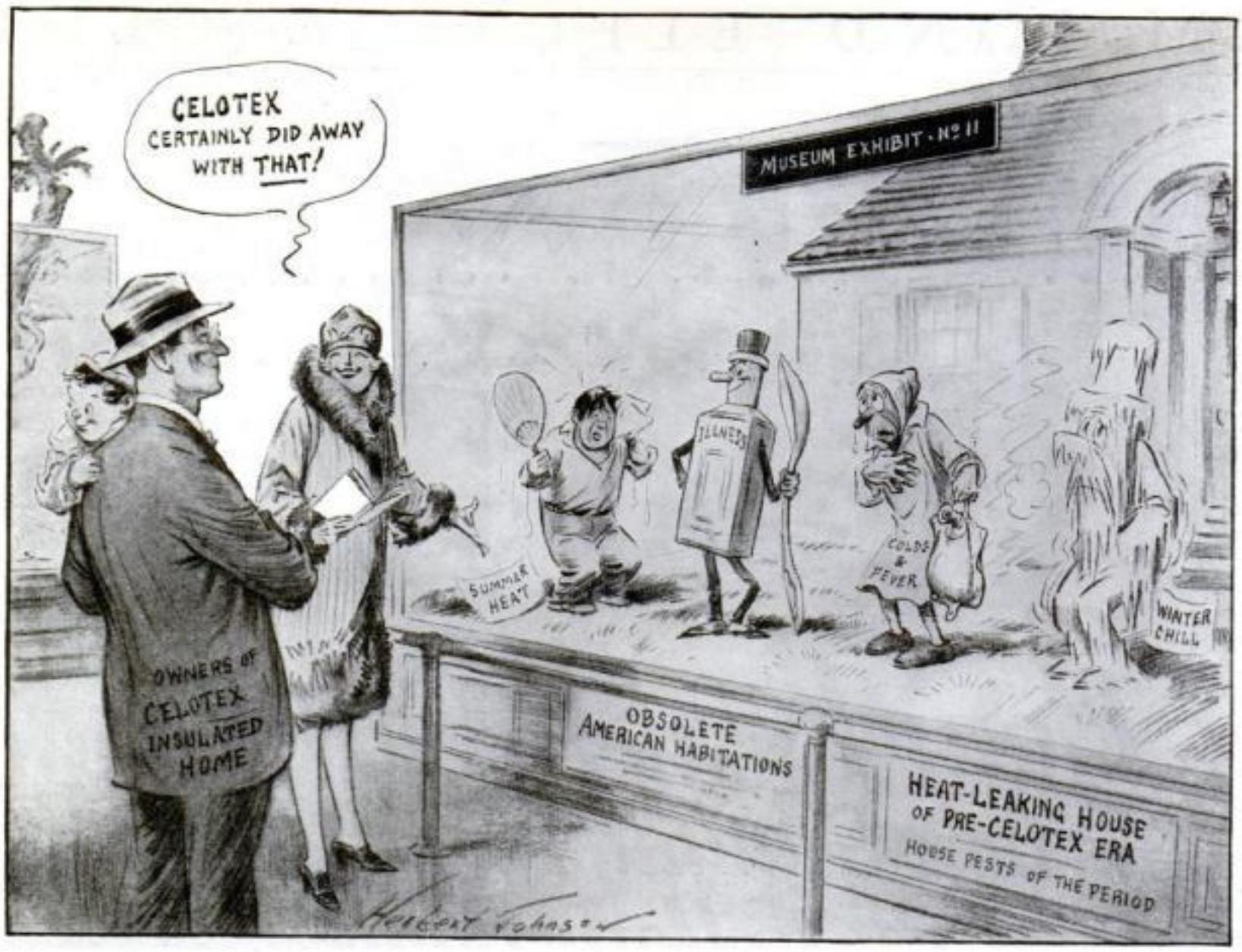
THE HAMMOND CLOCK CO.
4115 Ravenswood Ave., Chicago, Ill.
Please send descriptive folder on the Hammond Electric Clock.

Name.....

Address.....

City or Town.....

State.....



Behind the Bars of the Past . . .

TAKE a last look at these household imps of the pre-Celotex era!

Securely imprisoned behind the bars of the past, these pests can no longer infest your home with sickness and discomfort.

For they thrive only in old-fashioned, heat-leaking houses. And since the appearance of Celotex, thinking people have learned to replace heat-leaking construction with insulation.

Celotex is the only insulation made from long, tough fibres of southern cane. These fibres are interlaced into big, strong boards, 4 feet wide, 7 to 12 feet long and 7/16 of an inch thick.

When used on the outside of houses, as sheathing, Celotex adds structural strength . . . makes walls tighter and more permanent.

And on inside walls and ceilings, you can obtain finer, smoother plastered surfaces with Celotex Lath. This new lath, 18 inches by 48 inches and 7/16 of an inch thick, is especially designed to reinforce against plaster cracks and eliminate lath marks.

Celotex is used in old homes as well as new for insulating roofs; for lining basements, attics and garages; for making comfortable extra rooms from waste spaces.

As insulation, Celotex is not an expensive extra item, because it replaces other materials, and in later years saves you hundreds of dollars on fuel bills.

Ask your architect, builder or dealer for further information on Celotex—and send in the coupon below for our free booklet.

The Celotex Company, Chicago, Ill. In Canada: Alexander Murray & Co., Ltd., Montreal. Sales distributors throughout the world. All reliable dealers can supply Celotex Standard Building Board and Celotex Lath.

THE CELOTEX COMPANY Pop. Sci. 5-29
645 North Michigan Avenue, Chicago, Ill.

Please send me free your illustrated booklet, "Year 'Round Comfort and Fuel Saving for Every Home."

*Name*_____

*Address*_____

*City*_____ *State*_____

The word CELOTEX (Reg. U. S. Pat. Off.) is the trademark of and indicates manufacture by The Celotex Company Chicago, Ill.

CELOTEX
BRAND
INSULATING CANE BOARD

When you buy a house, look for the Celotex sign. It is your assurance of greater home comfort.

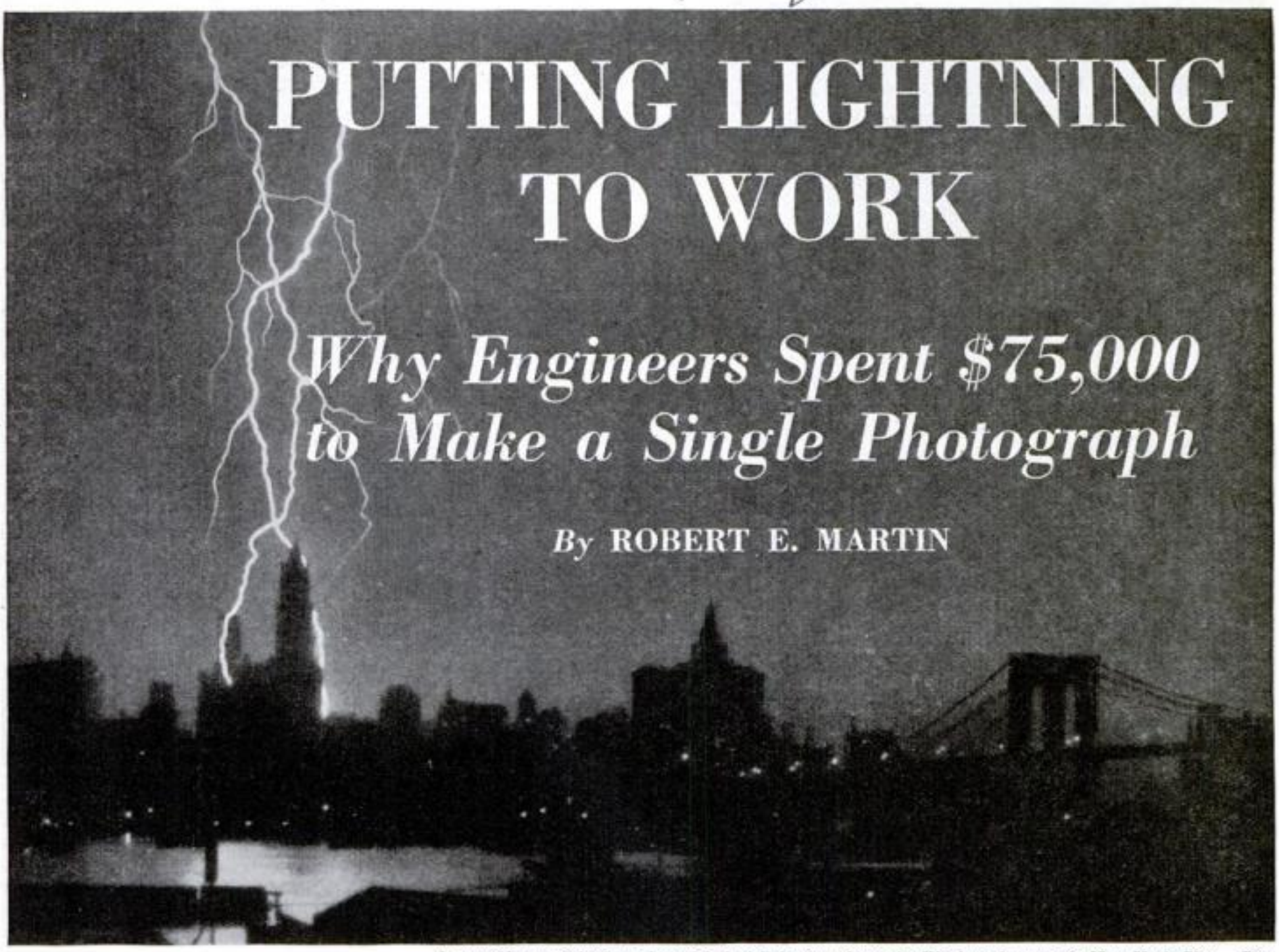
Popular Science
MONTHLY

MAY, 1929 SUMNER BLOSSOM *Editor* VOL. 114, NO. 5

PUTTING LIGHTNING TO WORK

Why Engineers Spent $75,000 to Make a Single Photograph

By ROBERT E. MARTIN



A magnificent nighttime play of forked lightning about the Woolworth tower in New York City. Skyscrapers are virtually lightning-proof, for their steel construction drains the electric fire to earth.

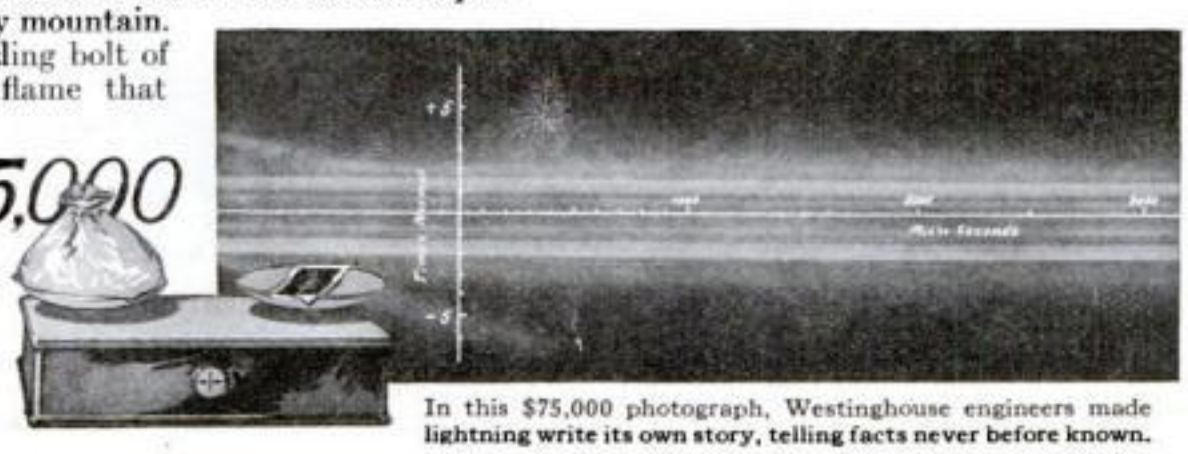
PACKED in a single lightning bolt is a thousand billion horsepower! In a flash measured in millionths of a second, almost unbelievable energy goes to waste—from sky to earth. This absorbing article tells how engineers are piercing the mysteries of Nature's mighty fireworks, and seeking ways to harness their titanic power for everyday use.

ENGINEERS of a great electrical concern spent $75,000, not long ago, to obtain a single photograph. And they considered the money well spent! The picture was of a flash of lightning. To the lay eye it resembled only a jumble of white lines streaking across a black field marked off into scale divisions. Yet the men who made the picture prized it as though it were a crown jewel. That single picture rewarded months of work of hoisting bulky scientific instruments to the top of a lonely mountain.

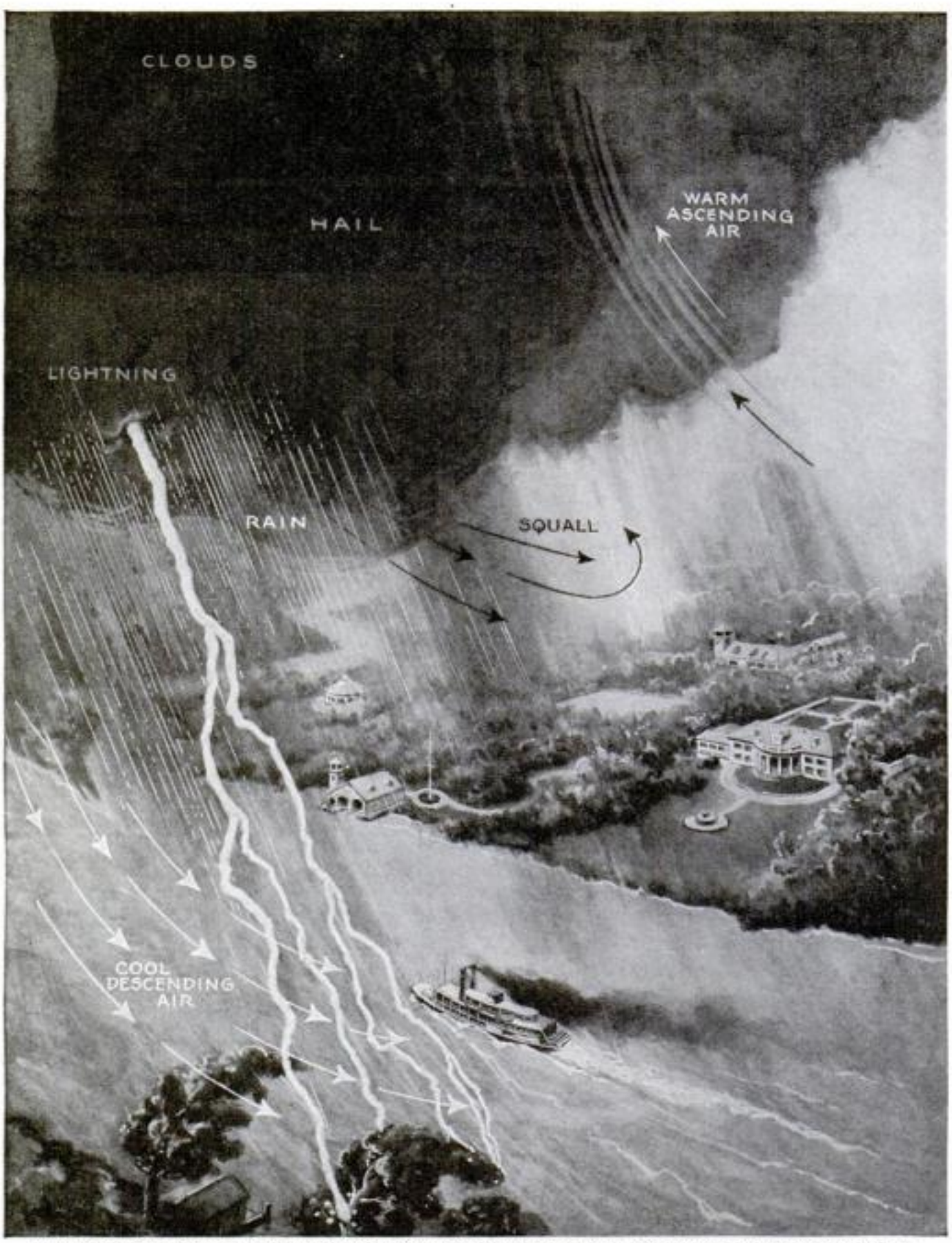
A dazzling bolt of white flame that crashed down upon Chilhowee Mountain, near Chota, Tenn., had been made to write its own autograph. And for the first time science had a record of a lightning bolt's entire life history—where it struck, its duration, its electrical power, and its effect upon a near-by transmission line.

Within the last few months such experiments have opened a new chapter in our knowledge of atmospheric electricity, and new possibilities of putting that knowledge to practical use. Now that lightning's titanic power is known in such familiar terms as an electrician uses to rate a dynamo's output, that information is being applied to realize long-awaited "lightning-proof" electric transmission lines. Engineers say that these must precede their dream of a super-power system to link whole sections of the country in electrical tie-ups.

Indoors and out, newly-developed machines forge bolts of artificial lightning today. They test rods and systems designed to ward off Nature's lightning from buildings and oil tanks; and they double



In this $75,000 photograph, Westinghouse engineers made lightning write its own story, telling facts never before known.



How lightning is formed. In a squall preceding a thunderstorm, warm and cool air, meeting in turbulent eddies, tear apart molecules of moisture and pile up their electric charges on the clouds. At last an accumulated charge leaps to earth in a blinding flash. Thunderstorms often follow courses of rivers and streams.

for natural lightning in testing power lines. Tomorrow they may have other revolutionary uses, such as blasting apart atoms to transmute metals.

Can Jove's bolts themselves be harnessed? Scientists are considering the possibility. In the Swiss Alps a party of bold experimenters are seeking to trap lightning with weird antennas and force it to transform familiar substances into others perhaps new to science. And to practical engineers, the thousands of billions of horsepower that go to waste in every lightning flash are a tempting prize. A bolt is launched every second, they estimate, in one of the 1,800 thunderstorms raging somewhere on earth at all times.

EVER since Benjamin Franklin drew sparks from a key tied to a kite string and proved that lightning was electricity—in 1752, or thereabouts—experimenters have spent much time and money seeking more facts about it that they could put to practical use.

Last summer two expeditions of engineers fared forth to study and measure lightning's force, armed with new instruments of astounding ability. In the foothills of the Allegheny Mountains near Lake Wallenpaupack, Pa., engineers of the General Electric Company made their camp beside a 220,000-volt transmission line—the first line operated at so high a tension ever built in a lightning-infested territory. Meanwhile experts of the Westinghouse Electric and Manufacturing Company encamped upon the summit of Chilhowee Mountain, near Chota, Tenn.—said to be one of the stormiest sections in the United States—beside a 154,000-volt transmission line.

The purpose of each expedition was to photograph the surge of electric current over a power line struck by natural lightning, using marvelous new cameras capable of recording what could happen in a millionth of a second or less.

Up Chilhowee Mountain the Westinghouse engineers hauled their automatic camera, a "Norinder oscillograph" so sensitive, for all its two-hundred-pound weight and seven-foot height, that it could record an electric flash lasting only a ten-millionth of a second—the time taken for a high-powered rifle bullet to traverse the thickness of two hairs.

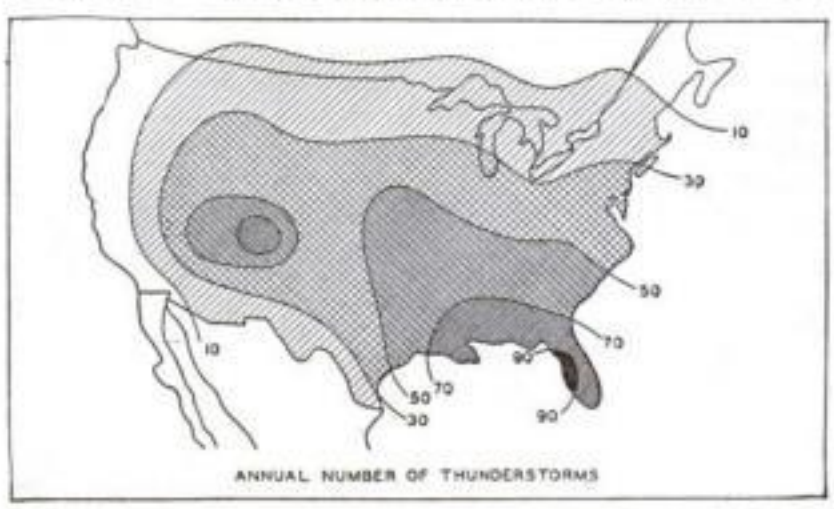
AN OVERHEAD lightning bolt jarred the clouds as it rocketed past the transmission line. The automatic camera whirred, later to disgorge a picture of the 650,000-volt discharge in the power line produced by the flash. It was a $75,000 picture, the only one to reward a whole season of expense and labor—but it showed as never before just what happens when lightning threatens power wires.

Meanwhile the General Electric engineers' camera, a high-speed cathode-ray machine, had recorded a phenomenon never before measured. In the midst of a thunderstorm, a streak of flame from the heavens landed with a deafening crash squarely upon the transmission wires! The camera was on the job. When the picture was developed it showed that the camera had recorded a high mark of 2,500,000 volts!

The work of these men has made it possible at last to reconstruct a fairly accurate picture of a lightning bolt.

One hundred million volts—twenty times the most potent electrical force that man's mightiest electrical machines have generated. One hundred thousand amperes—and it takes but half an ampere to light an ordinary electric lamp. A thousand billion horsepower—and all the machines in the United States, from turbines to automobiles, and electric motors to locomotives, use less than a billion! That is a picture of a typical lightning bolt, lasting from one to ten millionths of a second.

Only by such exact knowledge is it possible to build a power line so proof against lightning that its poles will not



In the United States thunderstorms are most frequent in the Gulf Coast region and southwestern Colorado. The Pacific Coast is almost immune. Parts of Florida are hit the hardest.

shatter, its insulators break down, nor electrical machinery connected to it burn out if a stray bolt hits it. Such a line is essential if whole states and sections of the country are to be tied together in an electrical system.

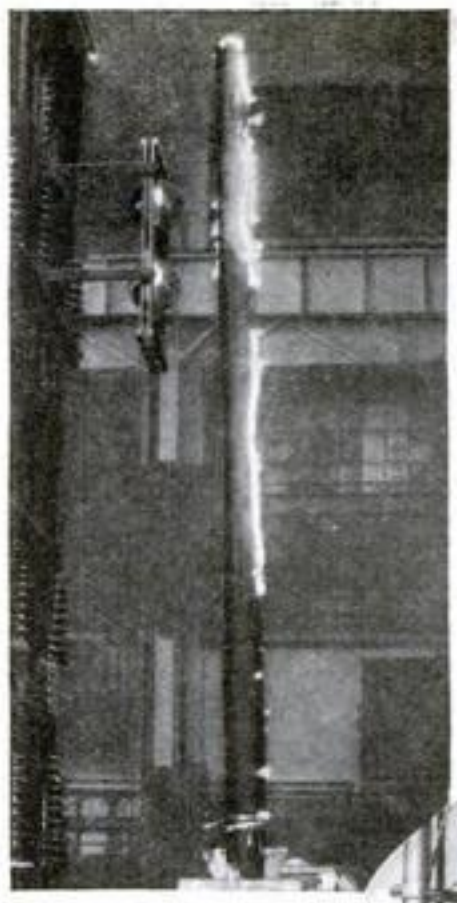
Now that the power of natural lightning is known definitely, artificial lightning may be used as well for tests. For years engineers have been trying to imitate Nature's lightning. At Pittsfield, Mass., engineers of the General Electric Company announced in 1921 the then unprecedented achievement of a million-volt bolt. Two years later they were producing 2,000,000 volts. In 1928, 3,500,000 volts was obtained; and only last January a 5,000,000-volt bolt crashed between two brass balls in the Pittsfield laboratory, as the entire power of four whirring dynamos was short-circuited in a single mighty flash.

NOW the General Electric Company has developed an artificial lightning machine which can be carried from place to place in a truck, to test transmission lines. It is putting to work lightning of hundreds of thousands of volts, that leaps in a blue flash between two spheres of brass. It is the first "portable thunderstorm" ever invented.

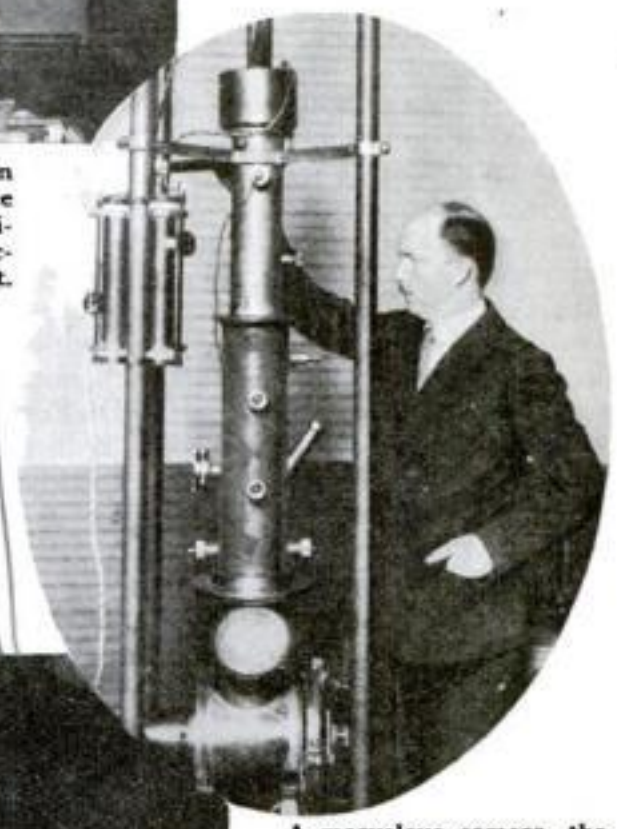
Other uses for lightning, both man-made and natural, are just around the corner. The Carnegie Institution at Washington, D. C., has developed a 5,000,000-volt machine with which, when suitable vacuum tubes are developed to apply its mighty power, they may blast atoms and transmute metals.

Still, man-made machines have yet to approach the electrical pressures manufactured by Nature. The vivid flashes of a thunderstorm appear in several guises. The familiar forked or "chain lightning," the deadly variety, is simply an electric spark on a monster scale. "Sheet lightning" usually is the reflection of distant forked lightning from the clouds, while the rare and often disputed phenomena of "ball lightning" apparently consists of fiery balls that some observers claim to have seen floating through the air during an electrical display.

A thunderstorm starts as a small cloud, perhaps less than a mile wide, that picks up new clouds and spreads out in a fan-shaped path. It courses across the country at about thirty miles an hour. A person with a speedy car and an expert knowledge of roads could outdistance it. Along the front of the rain-dripping cloud, heated humid air rushes upward as in a chimney, piling the front of the cloud into the typical white billows of a "thunderhead." A forward-rushing wind from the cold descending air in back—the squall that precedes a thunderstorm—meets the updraft in turbulent eddies. That is Nature's dynamo. The eddies break up molecules of the water vapor in the saturated warm air and separate their positive and negative electrical charges. Electricity piles up on the clouds until the strain due to a difference in electrical pressure between two clouds, or between one cloud and the earth, breaks down the resistance of the air between. Then a brilliant flash, often a mile long, leaps across the gap. Air heated by its passage leaps aside to leave a hollow tube of vacuum, into which the compressed air crashes back. The concussion is what we know as thunder.

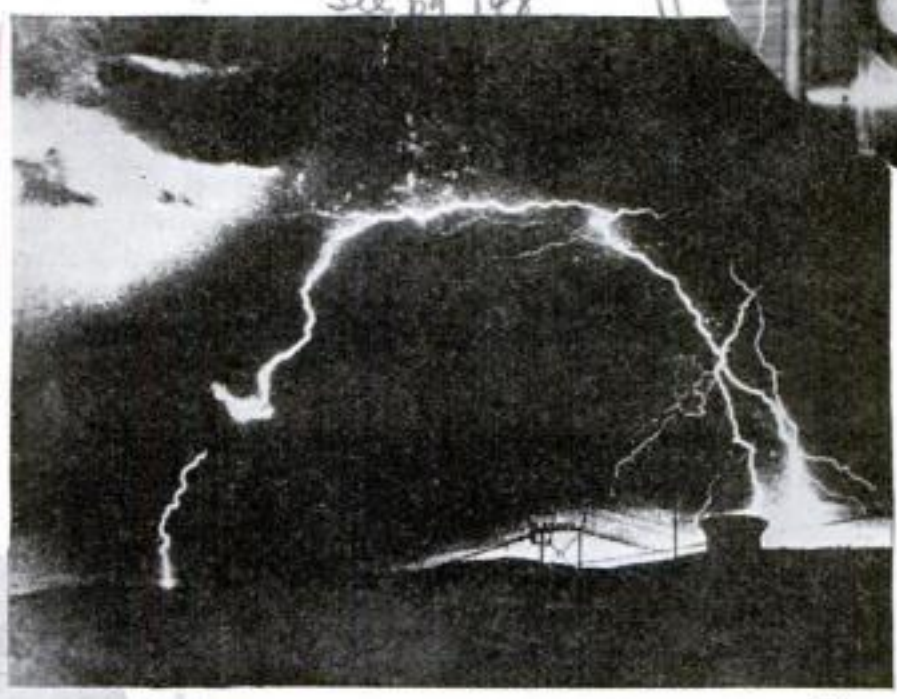


A twenty-foot wooden pole "struck" by three million volts of artificial lightning. A spectacular laboratory test.



A marvelous camera, the "Norinder oscillograph," used by Westinghouse engineers to measure power of natural lightning. It can record an electric discharge lasting only one ten-millionth of a second.

The light of a flash reaches us almost instantaneously, while the noise of thunder travels at the speed of sound, roughly a thousand feet a second. Thus it is possible to estimate the distance of a lightning flash with a watch or by counting seconds. Every five seconds that elapse between the time of sighting the flash and hearing the thunder represent about a mile of distance. If twenty-five seconds pass, for instance, before the sound is heard, the bolt is five miles away. The rumble of a distant thunder clap is its echo from surrounding clouds.



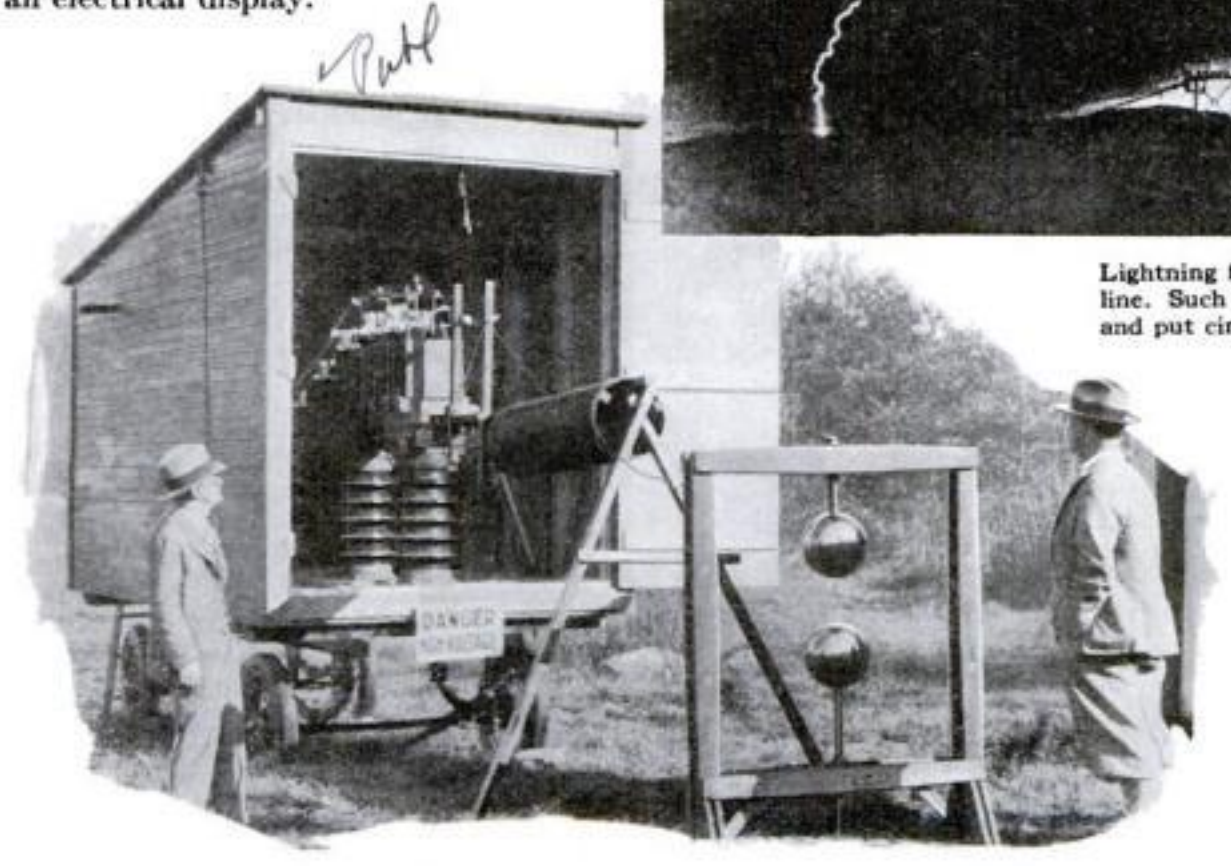
Lightning flash near a transmission line. Such a bolt may splinter poles and put circuits out of commission.

Frequency of thunderstorms varies according to location. Practically unknown in the Arctic region, they are most frequent and violent in the tropics. Southwestern Colorado and the Gulf Coast lead in the United States, while the Pacific Coast is comparatively immune. San Francisco averages less than one thunderstorm a year, while Tampa, Fla., is shaken by an average of more than ninety. New York City and Chicago weather from thirty to fifty a year.

Many are the proverbs and superstitions concerning lightning.

"Lightning never strikes twice in the same place"—there is a good old-timer. But the Eiffel Tower in Paris, to mention one example, has been struck dozens of times.

(*Continued on page 148*)



Using a "portable thunderstorm" to test a lightning-proof device for a transmission line between Turners Falls and Pittsfield, Mass. The apparatus carried on the truck generates artificial lightning at hundred of thousands of volts and applies it to the line, imitating effects of a real thunderbolt.

L. S. Buffington, inventor of the skyscraper, receives his first royalty.

Glimpses *of* Men *in the* Public Eye

Lejaren Hiller, camera illustrator, at work on a model of the Sphinx.

WHEN, a little more than ten years ago, Edward R. Armstrong first propounded his idea of building a series of great floating airdromes and anchoring them at intervals across the Atlantic to provide way stations for a regular flying service between America and Europe, the public regarded it as a fantastic dream. Aviation experts took the idea more seriously. Armstrong's words, as consulting engineer in charge of mechanical and chemical experimental development for the Du Pont company, carried authority. Still, realization of the project was considered a thing of the dim future.

Now Armstrong's conception is about to become a reality. A syndicate of New York financiers has backed the plan with millions. And shortly we may see winged liners flying from New York on a thirty-six-hour schedule across the Atlantic, pausing at 400-mile intervals on huge floating airports for fuel and weather reports.

Actual construction of the first Armstrong seadrome is to be started in August. It will be built along lines described previously in POPULAR SCIENCE MONTHLY inside the Delaware Capes near Cape May. The job should be finished by June or July of next year. The plan is to anchor it at a point midway between New York and Bermuda. But the complete project calls for seven more such ocean airports—a string of eight artificial islands stretching across the sea from our Atlantic coast to the Azores!

Edward R. Armstrong, inventor of floating ocean airdromes.

Armstrong's career has been a curious crazy quilt of vocations. At one time, he was featured as the strong man in a circus! And this despite the fact that Nature, apparently, had meant him to be a physical weakling. When he came into the world at Mount Forest, Ontario, Canada, in 1877, he weighed exactly three pounds! The puny baby grew into an undersized and sickly boy. But when he was about eleven, a chance remark by his mother that he would never be as strong as his father determined him to improve his physique. The result was a triumph of will power. When he was nineteen, he was famous for his prodigious feats of strength and his lectures on health.

After about a year of weight-lifting, cable-breaking, and health missionary work, he decided to go in for wrestling. At twenty, he was in a fair way to become the wrestling champion of the world, but his prowess somehow didn't satisfy him. In Cleveland, Ohio, at the time, he picked up the threads of a rather desultory education and took an engineering course, after which he joined a railroad surveying crew.

His climb in the engineering world was a steady one. Once, however, he turned away from the profession for a brief, strange interval. Attending a circus with some friends, he jokingly remarked that he could easily duplicate all of the tricks performed by the star strong man and teach him a few new ones besides. This he did after the show. The strong man being about to quit his job, Armstrong took his place and for two months traveled with the "big top."

Five years of surveying work in the Texas oil fields followed. About that time the Wright brothers developed their first plane and Armstrong took a keen interest in aviation. He experimented in building seaplanes, but abandoned this work when he found they were not practicable for long sustained flight. At the beginning of the World War, Armstrong joined the Du Pont company.

A Great Engineer and Adventurer

THE American Institute of Mining and Metallurgical Engineers recently bestowed upon John Hays Hammond the William Lawrence Saunders medal, the highest award within its power to confer. The award came as one of the crowning glories of a distinguished career as an engineer.

John Hays Hammond, has wrested riches from the earth.

Hammond's genius has carried him to California, Mexico, Russia, China, Japan, and Siberia to open mines, build railroads, clear jungles, bridge rivers, level mountains, and construct highways. He is now seventy-four years old. The story of his life is the stuff of which the world's great romances are made. For he has been not only an engineer, but also an adventurer and soldier of fortune. In the stirring days that preceded the Boer War in South Africa, for example, Hammond's activity as a leader in an attempted revolution won him imprisonment in an African cell and a sentence of death!

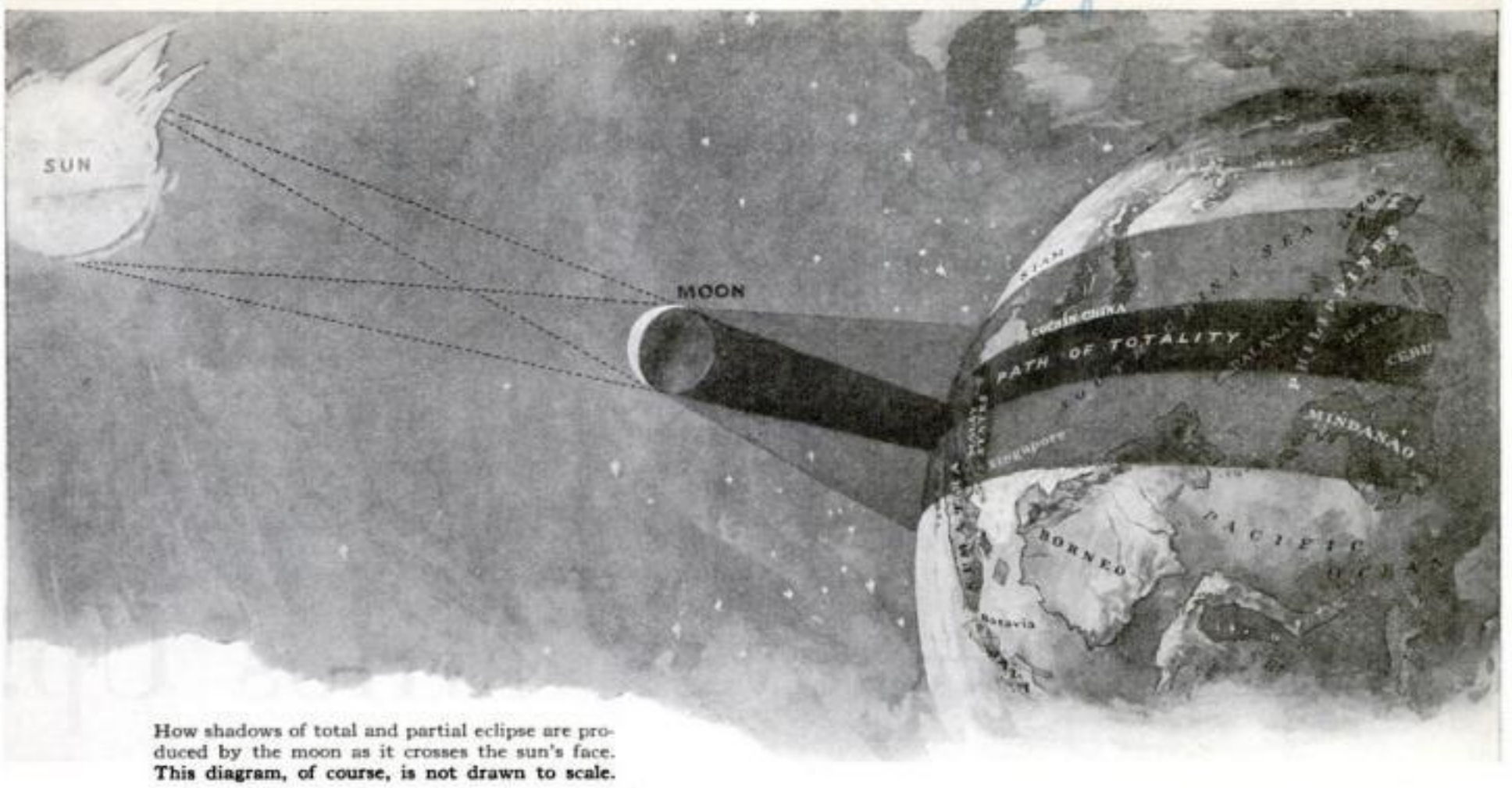
At that time, at the age of forty, he was in the employ of Cecil Rhodes, the "empire builder," in charge of the great gold mines at Johannesburg, and of the development of mineral deposits in Rhodesia. There had been a long series of injustices to the "uitlanders," or foreigners, who, though bringing brains and capital to the country, were denied a voice in the government. The Johannesburg mining community deemed the overthrow of "Oom" Paul Kruger, president of the Transvaal Republic, the only means of relief. A crisis came about 1895. Plans were laid for a revolt, in which Hammond became one of the leaders.

Arms were smuggled in, but delay in their arrival brought on the famous Jameson Raid which resulted in Hammond's arrest and sentence to be hanged for high treason. A storm of protest arose throughout the world. After months of negotiation, Hammond was finally released on the payment of $125,000.

After a few years in England, Hammond returned to the United States in 1900, and during the ensuing ten years devoted himself to the development of some of

(Continued on page 129)

Arthur D. Little, chemist, turns waste into wealth.

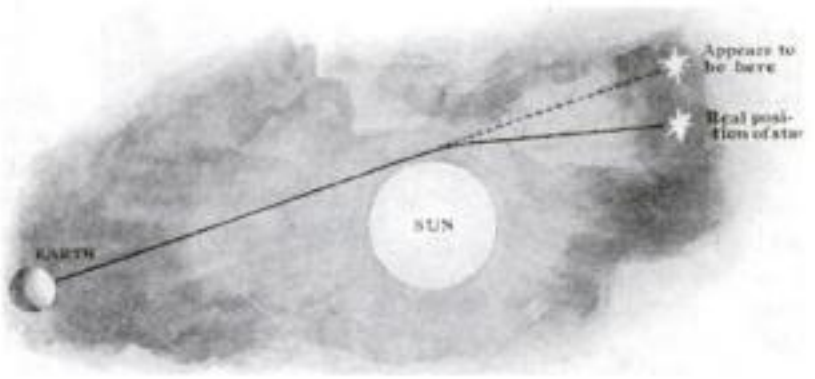


How shadows of total and partial eclipse are produced by the moon as it crosses the sun's face. **This diagram, of course, is not drawn to scale.**

Eclipse to Check Einstein

Astronomers Journey Halfway Around the World to Study Five-Minute Spectacle, as the Moon Blots the Sun's Face

By GEORGE LEE DOWD, JR.



Photographs during the eclipse will test Einstein's theory that the light from a star is bent from its course in passing the sun, so that its apparent position in the heavens is not its real position.

EINSTEIN'S theory of relativity receives a new test in the wilds of Sumatra in the Dutch East Indies on May 9, when leading astronomers of Europe and America study and photograph a remarkable five-minute total eclipse of the sun, for which they will have journeyed halfway around the world. The duration of the eclipse, and the fact that this island off the Malay Peninsula lies directly in its path, offer an unusual opportunity for scientific observation. The average eclipse lasts only from one to four minutes, and the longest possible duration of a total eclipse for a single observer is seven minutes and fifty-eight seconds.

As the moon passes across the face of the noonday tropical sun, its shadow, a hundred miles wide, will stretch a ribbon of darkness over the central islands of the Philippines, southern Siam, Cochin-China, the Malay Peninsula, and Sumatra. At different points along the path of this shadow, expeditions from the United States, England, France, Germany, and Holland will await its coming.

For weeks before, the members of these expeditions will have rehearsed their parts in changing camera plates and checking observations. During the precious minutes of darkness, they will work with the speed and efficiency of mechanics changing the tire of a racing auto. If it rains or is cloudy during those five minutes, a quarter of a year of preparation and travel will be lost by the expeditions to Sumatra. That island will not see another total eclipse until 1988.

During this miniature midnight, the stars in the neighborhood of the sun will be photographed. To test the Einstein theory, the same stars will be photographed again at night. Their positions in the two photographs will be compared. If they appear to be in a different position in the eclipse photograph, it will indicate that the light rays were bent out of their courses in passing the sun, in accordance with the theory of the famous German scientist. Similar tests, made by British observers in 1919, tended to confirm the Einstein theory, while those made at the Lick Observatory in California during the eclipse of 1922 showed almost the identical displacement of stellar images predicted by him. But some other tests are said to have indicated deviations from his formula, so the expeditions are placing tests of the famous theory at the head of their list of experiments.

Two other experiments, during the five-minute eclipse, may result in important new discoveries. In one, the effect of a total eclipse upon the transmission of radio waves will be studied. The other will attempt to determine the exact nature of the corona, that mysterious glowing envelope that surrounds the sun and sends its streamers millions of miles into space.

DURING the 1925 eclipse, visible in the eastern part of the United States, scientists on board the Navy dirigible *Los Angeles* drew the outline of the corona as seen high in the air. At one time it appeared like a fiery octopus, at another like a box-elder leaf. It is possible that observers in distant Sumatra may discover whether this corona is gaseous, liquid, or solid, and may even determine its chemical composition.

There they were at the seven-mile ceiling, and the motor wouldn't slow down! Their oxygen supply was running lower and lower. Minutes seemed like hours.

Stranded—Seven Miles Up!

AND that's a long way from home, when you're touching the icy ceiling in a plane that won't come down—and breathing from a bottle! Here's the story of a flyer whose thrillers in the air few pilots can equal.

By ALDEN P. ARMAGNAC

STUCK in the air seven miles above the earth. No way to come down until the plane ran out of gas. Through holes the size of a thumb-nail in the lenses of his goggles, Capt. St. Clair Streett, U. S. Army Air Corps, stared at his balky controls. He couldn't shut down the motor!

That recent experience was one of a series of thrilling adventures that have befallen this doughty little pilot of Wright Field, at Dayton, Ohio, who has flown an airplane higher than any other man but one. My introduction to him was spectacular. I stood at the gate of the flying field watching a buzzing swarm of planes cavort in the air.

"You want to see 'Billy' Streett?" the officer asked me. "There he goes!"

Across the leaden gray afternoon sky blazed a strange apparition—a dazzling ball of fire on the wing tip of a giant bomber. A staccato roar of exhaust echoed in my ears as the aerial shooting star passed. Could the plane be on fire?

It came to earth, and Captain Streett hopped out to put my fears at rest. "Flares," he explained, "for night landing. We test them here." For Captain Streett, as chief of the flying branch of the Air Corps' Matériel Division, has charge of the testing of new planes and equipment.

Here is a veteran, at thirty-five, of narrow escapes from death. Once when flames, in mid-air, licked dangerously near the gasoline tanks of a plane he was piloting, he won a fifteen-mile race with them to the nearest landing field. Another plane somersaulted and pinned him beneath it; he crawled out without a scratch. On one occasion he tore the fabric off a wing in mid-air—and landed safely. For leading the first aerial expedition to Alaska in 1920 he won the coveted Distinguished Flying Cross. And, a few weeks ago, he topped off a career of thrills by a flight that earned for him and his companion the altitude record for a plane carrying two men—and very nearly a world's altitude record for all planes, as well.

The highest photograph ever taken, showing an area of thirty square miles in the vicinity of Dayton, O., from an altitude of more than seven miles. It was snapped by Capt. A. W. Stevens, seen above with his aerial camera, in the plane piloted by Capt. St. Clair Streett (left). On this flight Streett had the hair-raising experience related in this article.

Seven miles high! Captain Streett had shed his flying togs, and escorted me to a cozy green cottage at the field's edge—shared by his wife and his year-and-a-half-old boy. His pipe lit, he was telling me of his latest exploit. A boyish, rather slight figure—I thought of the great bomber I had seen him piloting. Brown hair, a close-cropped mustache. It seemed hard to believe that this mild-mannered young man was the aerial adventurer that his record showed. Quite obviously he disliked to talk about himself. But the story came out:

A FRIEND of Captain Streett's, Captain A. W. Stevens—in charge of the Aerial Photographic Unit at Wright Field, and probably the world's foremost sky photographer—had a new way, he thought, of measuring a plane's altitude. He believed that if he could take aloft a camera and shoot pictures of the earth from a sky-sailing plane, he could tell by measuring distances on them how high the plane was. Would Captain Streett take him up to try it? He certainly would.

But this was to be no simple trip over Wright Field. They would take an XCO-5 plane—the same fragile high-climber that

former Lieut. John A. Macready, dean of altitude flyers, used for his dashes into the upper air—point its nose up, and keep ascending.

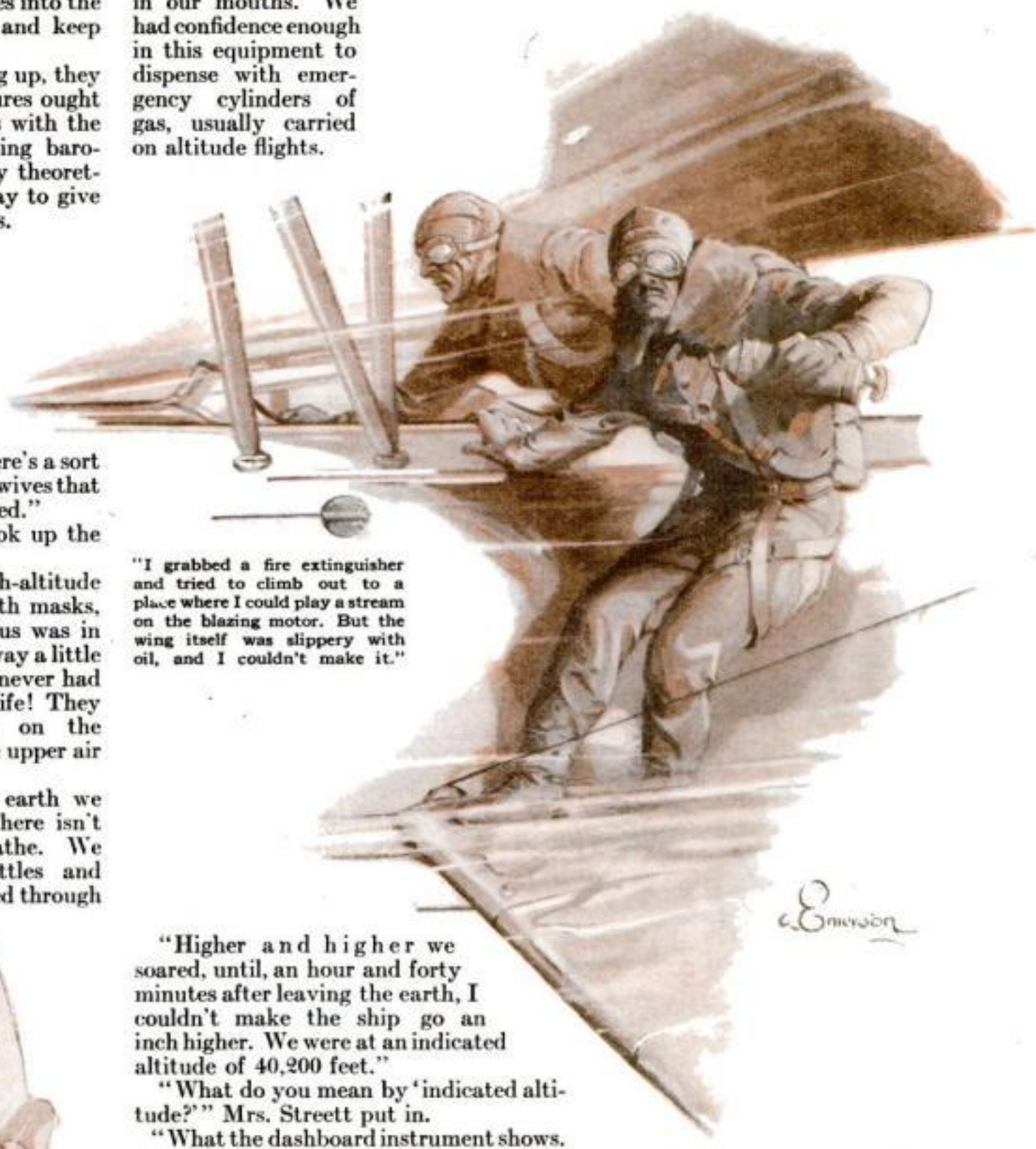
When the plane stopped going up, they would take pictures. The pictures ought to give interesting comparisons with the records of the altitude-indicating barographs that are "corrected" by theoretical and disputed formulas today to give the world's official height marks.

"I DIDN'T want him to try it," Mrs. Streett confessed, when the captain excused himself to find some cigarettes. "Seven miles is too far up in the sky, I think! But I didn't breathe a word of what I thought to Billy. You know, there's a sort of unwritten code among flyers' wives that they mustn't admit being worried."

Captain Streett returned, took up the story.

"We struggled into our high-altitude costumes, covered our faces with masks, saw that our oxygen apparatus was in working order, and were under way a little after eleven in the morning. I never had quite as many clothes on in my life! They were mighty uncomfortable, on the ground, but when we struck the upper air we thanked God for them.

"At 15,000 feet above the earth we commenced taking oxygen. There isn't enough air, up there, to breathe. We carried liquid oxygen in bottles and breathed it, after it had vaporized through a valve, through tubes in our mouths. We had confidence enough in this equipment to dispense with emergency cylinders of gas, usually carried on altitude flights.



"I grabbed a fire extinguisher and tried to climb out to a place where I could play a stream on the blazing motor. But the wing itself was slippery with oil, and I couldn't make it."

Dangling from his parachute, Lieut. Hutchinson looked up to see the pilotless plane, now a mass of flames, heading straight for him!

"Higher and higher we soared, until, an hour and forty minutes after leaving the earth, I couldn't make the ship go an inch higher. We were at an indicated altitude of 40,200 feet."

"What do you mean by 'indicated altitude?'" Mrs. Streett put in.

"What the dashboard instrument shows. It isn't exactly correct, due to differences in temperature at different levels. Actually our official height turned out to be 37,854 feet—between seven and eight miles high."

Incidentally this is the unofficial world's record—there is no official record—for two men in a plane, and a mark within only 564 feet of the free-for-all airplane height mark of the world, set by Lieut. C. C. Champion, U. S. N.

"COLD up there? You don't know what seventy-six degrees below zero feels like until you've been there. But Stevens was merrily taking pictures as fast as he could operate his camera, his fingers warmed by an electrically-heated pair of mittens. At last he tapped me on the shoulder to signal he was through. I started down.

"Then a strange thing happened. As we coasted down on an easy glide, I started to slow down the motor so that we could keep on descending—and the motor wouldn't slow! My controls seemed to be stuck. By diving I managed to get down a few thousand feet, but the plane, with its propeller whirring away full tilt, wanted to climb right back up again.

"I didn't do any more diving. In a frail ship of this special type, the uprush of air in a forced dive would tear off the wings—and I didn't want to lose them up there! There I was, trying to shut the motor off, and I couldn't do it!"

Minutes passed—minutes that must have seemed like hours, with the oxygen in the bottles running lower and lower, and no reserve supply aboard. In about twenty minutes, the motor began to cough and splutter. Then it stopped completely. The gas was gone. Down came the plane, gliding like a fragment of paper tossed by the wind.

"I hadn't the faintest idea where we were," Streett continued. "We had started over Dayton, but that was a long time ago. My goggles were covered with frost, and my view was limited to what I could see through a hole the size of my thumb-nail cut in each lens. I had no idea what city or town we were over, for when you are that high ordinary landmarks—buildings for instance—are too small to guide you.

"WE tobogganed to earth, the motor catching now and then as a few remaining drops of fuel trickled into the gas line. When we got down to a warmer level I lifted my goggles and looked around. The first thing I saw was Indianapolis, dead ahead. We had drifted and glided about seventy miles. (*Continued on page 156*)

War Gas Fights Peace-Time Foes

How Uncle Sam's Chemists Employ Trench Poisons to Rout Bandits, Slay Insect Pests, Quench Fires

By ALFRED P. RECK

Fumigating a U. S. Army bakery with mixture of the fearful hydrocyanic gas, used in French war shells, and tear gas. The latter, by inducing tears, warns of the deadly poison's presence.

Maj. Gen. Amos A. Fries, Chief of the U. S. Army Chemical Warfare Service, which is turning poison gases of war to peace-time uses.

A HIGH-POWERED automobile rolled up to a bank in a mid-western city a few months ago. It was just after the opening hour in the morning. Three flashily dressed young men stepped out while a fourth sat at the steering wheel. The three passed through the revolving doors of the bank.

Inside, the cashier was sorting neat piles of green- and gold-backed bills. He looked up as a form darkened the brass-barred windows of his cage.

"Yes, sir, what can I do for you?" the cashier asked.

The next instant he was looking into the muzzle of an automatic pistol.

"Just shove over those bills and be quick about it!" the young man commanded sharply.

The cashier's smile disappeared. Underneath the marble ledge of the window, his foot found a button. He pressed hard.

There was no sound, no shriek of siren, no clamor of alarm bells. But almost immediately the bank was filled with a dim haze—almost like the smoke of burning tobacco.

The bandit coughed. Great tears welled down his face. Then he dropped his pistol and rubbed his eyes with both hands.

"I'm blind!" he shrieked to his companions; but they were too busy rubbing their own aching eyes to come to his aid.

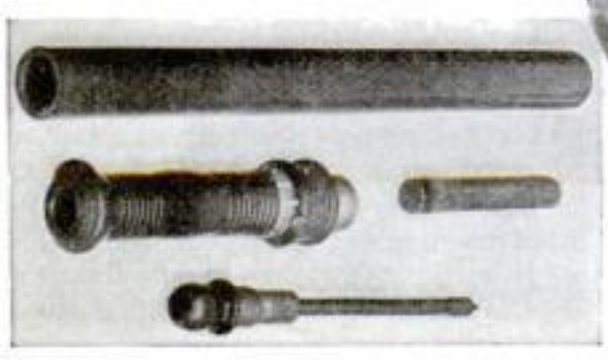
The three attempted to stagger toward the door. They bumped into desks and fixtures and were alternately rubbing their eyes and groping along the floor when the police arrived, threw open the doors, and fastened handcuffs on three thoroughly tamed but cursing bandits.

When they were able to see again, a half hour later at police headquarters, their eyes were slightly inflamed but otherwise they were unharmed.

"What happened?" they asked.

"You guys just bumped into a little tear gas and came crying into our arms like mamma boys," a hard-boiled sergeant answered.

That thwarted bank robbery testifies to the success of the U. S. Army Chemical Warfare Service's experts in finding peace-time jobs for poison gas. Under Maj. Gen. Amos A. Fries, these wonder workers have found a score of novel ways to put to work the toxic vapors and gas-spraying equipment that the war created.

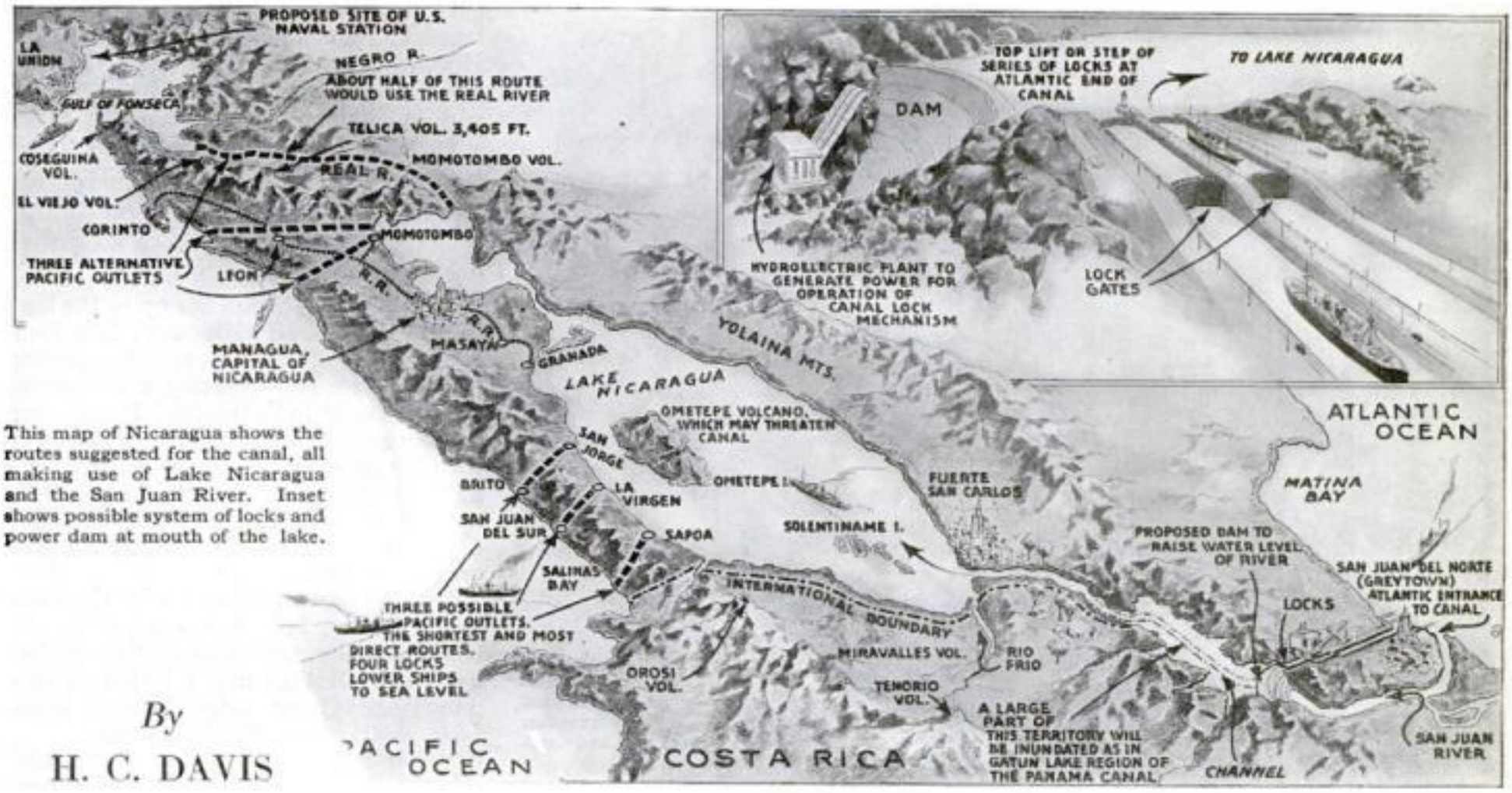


Experimenting with chemicals to exterminate the boll weevil, destroyer of cotton crops. At left: A tear gas bomb in a policeman's billy.

"BANKS and jewelry stores are secretly installing efficient tear-gas systems," General Fries told me when I talked with him in his office at Washington, D. C., the other day. "It is next to impossible even for a trained eye to detect the openings of tubes that eject the gas, so cleverly do they blend with the fixtures. In a few seconds the potent gas will stop the most carefully planned holdup. The Chemical Warfare Service advises banks and institutions as to the best gas to use and the way to use it."

An entirely different application has been the safeguarding of household gas appliances. Your home, particularly if it is in the West, or located near an oil field, may use natural gas for the kitchen range. In that case, you are safe, for the odor of escaping gas is unmistakable. But the manufactured variety widely used is itself a "poison gas." The more deadly it is, the less noticeable its odor. Cases are on record of women who have fallen unconscious in the (Continued on page 159)

A Bigger Ditch *Than the* Panama



This map of Nicaragua shows the routes suggested for the canal, all making use of Lake Nicaragua and the San Juan River. Inset shows possible system of locks and power dam at mouth of the lake.

By
H. C. DAVIS

With an Engineer-President, Uncle Sam Soon May Dig a Billion-Dollar Nicaragua Canal

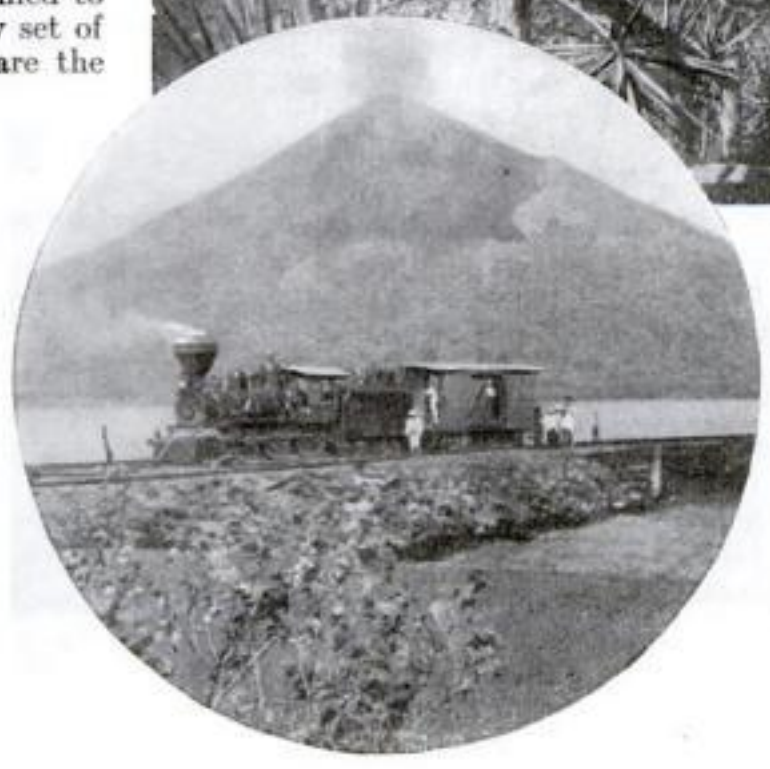
WITH an engineer for President and a new administration in Washington, a fascinating project that has long laid dormant now seems slated for action. For thirteen years the United States has held the exclusive privilege of building a canal across Nicaragua in Central America from the Atlantic to the Pacific, supplementing the "big ditch" at Panama. Will Uncle Sam go ahead now and do it?

At this writing the United States Senate has just voted an appropriation of $150,000 to survey possible canal routes. The first definite step has been taken toward a new Nicaragua canal bigger than the "ditch" at Panama—and some say it is none too soon.

Apparently the Panama Canal is nearing the limit of its capacity. It is being operated sixteen hours a day and already a new reservoir and dam are planned to augment its water supply. A new set of single locks may eventually share the burden of the double ones now working. Yet even with these improvements and twenty-four-hour-a-day operation, engineers see a time when the canal will be inadequate to carry all the ships desiring passage. Then a new canal will become imperative.

That is the setting for one of the most daring engineering projects of all time—one in which man must pit his hand against fever, sharks, and the menace of smoking volcanoes to blast a waterway across mountains and jungles of Nicaragua from sea to sea.

Once one half of Nicaragua rocked in a titanic upheaval of



A glimpse of the wild country through which the canal would pass—Lake Nicaragua in the distance. Left: Mt. Momotombo, the volcano which threatens the proposed northern route.

earth. Lava from a fuming volcano bottled up a whole arm of the Pacific Ocean. That arm is now Lake Nicaragua, a body of fresh water a third the size of Lake Erie.

The whole Nicaragua canal, on paper, centers about this lake. From it the San Juan River winds eastward to the Atlantic Ocean at San Juan del Norte, also known as Greytown, forming a link of water that almost cleaves the isthmus in two. But a (Continued on page 154)

Photographs of the author by D. Warren Boyer

I found that **you can learn** a lot by **hanging around** the field, **watching other pilots take off and land.**

I Am Learning to Be a Flyer

The First Forced Landing—Another Big Day in the Life of a Greenhorn Pilot

By LARRY BRENT

COLONEL CHARLES A. LINDBERGH gave me a valuable lesson in flying. Not a word passed between us. He did nothing but sit in the cockpit of his plane.

Everyone with whom I had talked at Curtiss Field since I enrolled as a student had said, in substance: "If you'll hang around the field and keep your eyes and ears open, you'll learn as much about flying as you will in the air. Watch how the other fellow does it, and learn how the other fellow has used his head in emergencies."

So every day, from early morning until dark, I was spending at the field, observing take-offs and landings, dropping in at this hangar and that, watching riggers and motor men at work on a dozen different makes of planes, listening to "shop talk" in the pilots' room, and, every afternoon, "going to school" from one to three in one of the hangars, attending lectures given by our instructors and by visiting pilots and aeronautical engineers.

In less than a week, I already had one notebook full of data on aviation terms and definitions, principles and theory of flight, rigging, engines, ignition, carburetion, instruments, aerology, navigation, meteorology, etc.

It was fortunate for me that I had learned shorthand in high school, and that I had, in the three years since leaving high school, worked as a newspaper reporter and learned how to grasp what was especially important.

The notes I was taking I put into typewritten form at my boarding house near the field every night. And I was studying these notes more diligently than I had studied any subject in high school. I wasn't flying for fun, but to prepare myself for a commercial flying career.

One morning I was talking with a lucky girl student—lucky because her wealthy father had just ordered a Laird-Whirlwind for her as a reward for her first solo—when a small plane came gliding down to the field and taxied up to the line. Some one near us said, "There's Slim now."

Except in the movies, it was my first glimpse of Lindbergh. A small crowd gathered at once about his plane. Lindbergh had flown north from Washington. His goggles were pushed up on his helmet. Minutes passed, and still he sat there with his motor running.

I was so excited at seeing him that I hardly heard Charles Gaver, the school manager, who was standing beside me. He was saying to me:

"GET that, Brent. A lot of so-called pilots would run her up to the line, cut the motor, and walk away. Not Slim! He'll sit there for fifteen minutes, cooling her down slowly—treating a motor the way she ought to be treated! It's the way he does everything. It's why he got away with his Atlantic hop. And it's why he's all the time flying all over without having to sit down. You can't be finicky enough." (To "sit down" means to make a forced or emergency landing.)

I jotted down all this under the notation, "Be finicky." It opened a big new chapter in my studies as an "apprentice flyer." Later that day I jotted down a great many more notes, because somebody had not been finicky enough.

When I had enrolled for my twenty-five-hour course, I had asked Gaver about students working to pay for their flying time. He had said that that practice had been discontinued because some of the students did such unsatisfactory work. One of the last of these work-your-way students—he was supposed to be a good mechanic—had adjusted the motor of the plane on which I took a flying lesson that day.

RANDY ENSLOW was my instructor, but so far I had seen nothing of him. He was home, ill, with flu. So again I went up with my temporary instructor, Lieut. Assen Jordanoff, a former ace with the German war birds.

When we had taxied to the end of the field for our take-off and I had adjusted my goggles and a helmet to which a speaking tube was attached, Jordanoff said: "This motor sounds rough to me."

My ears were not yet attuned to the finer shades of motor noises. The roar of

"Lindbergh treats the motor right, the way he does everything else," said Gaver.

this one sounded to me like all the rest of them.

His voice came through the speaking tube: "Are you strapped in?"

He turned and looked. I nodded.

"Do not touch the controls, please."

The plane commenced to move. As it gathered speed I watched, not the ground, as I usually did, but the controls, duplicates of those in the forward cockpit. The rudder pedals were working violently and the stick was wabbling, for, until a ship attains flying speed, the controls are very insensitive.

WITH the rudder Jordanoff kept the plane headed into the wind. With the stick he prevented it from tipping either way. Suddenly the stick went forward. This meant that our wheels were still on the ground, but that the tail skid was up.

Almost imperceptibly, the stick came back. The rudder pedals were moving hardly at all now. I looked out. Our wheels had left the ground. We began to climb. We made a turn over the hangars and continued to climb. When my altimeter read 1,000 feet, Jordanoff's deep voice said: "You will take the controls."

This time I was better prepared. My stomach seemed to be climbing up under my ribs and to be shrinking, but it was the only symptom of nervousness I felt. I was learning that a plane really *wants* to stay up in the air; that a plane is one of the most intelligent pieces of machinery in existence; more intelligent by far than an automobile or a power boat, and infinitely more sensitive than either.

I tried to remember all the things I had been told to remember. Hold the stick lightly. Keep the wings level with the horizon and the nose where it belongs on the horizon. Where the horizon should cut across the nose varies according to the height, seated, of the pilot. In my case, it was about two inches below the top of the radiator. It also varies with different ships. Once I have developed a flying sense, I can ignore the horizon. In fog or at night I will fly level, checking up my sense of balance now and then by glancing at certain instruments.

IT WAS rough today. We began hitting bumps. I seemed to be doing nothing right, in spite of the way I had sat, night after night, on the edge of my bed, drilling myself in what to do.

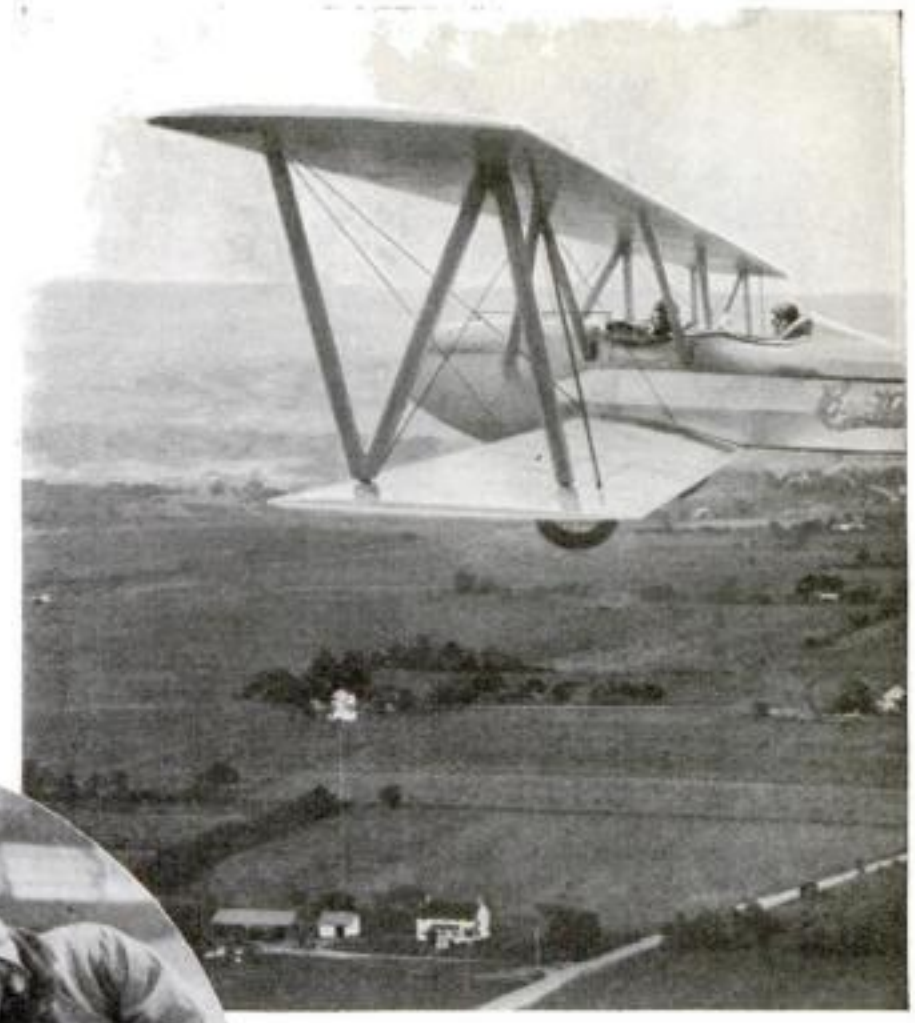
"Press your stick against that rising wing."

An air current had sent the right wing way up. I gave the stick a sudden push to the right. The wing came down.

"You are over-controlling. Hold the stick lightly."

I relaxed my grip. Suddenly the ship dropped. It seemed to drop from under me. We had hit an "air pocket"—erroneous term for a down draft of air.

"Release all controls," said Jordanoff. "We will have to land. This motor is bad." I did so. I looked down. The motor sputtered again. I knew we were about to make a forced landing.



Using a card to represent wings, Jordanoff explained the side-slip landing, and why it is necessary where there's not enough room to glide in, or if the wind is wrong.

It was my first glimpse of Lindbergh. Before he climbed from his plane, he ran the motor for fifteen minutes, cooling her down slowly.

"Your nose is too high."

I pushed the stick forward to put the nose lower.

"You are steering in a wide circle again. Pick some object on the ground and steer for it."

I PICKED a large white house in the center of a dense thicket—probably a millionaire's mansion. I could see it sliding slowly to the right, preparing to vanish under the plane. Very gingerly—remembering my bad footwork in previous flights—I touched the left rudder. I remembered that one control must not be worked without the other. I gave the stick a little twitch to the left. The house reappeared—straight ahead.

"Not bad," said Jordanoff.

My slipping confidence came back. I steered for the white house until it vanished astern, then I picked a cluster of white buildings farther away. I was not yet steering perfectly straight. The landmark would—very slowly—slide from side to side. Each time I would make corrections, using rudder and stick. Every few seconds, it seemed to me, Jordanoff would say:

"You are not keeping the ship steady. It is wabbling around. Keep it steadier."

When I would make a determined effort to keep the ship steadier, he would say:

"Now you are over-controlling. Don't grasp the stick. Try using just your thumb and one finger."

I wanted to protest that the air was so bumpy today that it was impossible to keep the ship steady. But the speaking tube worked only one way. I noticed that whenever Jordanoff had the controls, we flew steadily. There were bumps, but he corrected them so quickly that the ship did not wabble at all. Jordanoff later told me that an experienced pilot is so sensitive to the influences of air currents on his ship that he will often anticipate bumps before he strikes them and will act accordingly.

I jotted more items under the note, "Be finicky." Somebody hadn't been finicky enough.

I know now that, in those first few lessons, I was nervous and overanxious to keep the ship steady, level, and flying straight. I used will power that morning to relax my hand until I was hardly touching the stick. The ship continued to wabble. First one side would dip down, then the other. Next the nose would go down, and I would pull it back up. This was happening often.

I SAW by my altimeter that I was slowly losing altitude. Jordanoff had the throttle retarded. We were flying at low speed, yet if I were flying the ship properly we would not be losing altitude.

Presently I discovered that, while my hand on the stick was relaxed, the rest of me was rigid. I remembered that the school manager had told me always to ride the ship through. That had meant very little before. Now I tried it. I let my body relax—simply sat back and took it easy.

The result was magical. The ship immediately steadied. All wabbling stopped. Jordanoff said:

"That's much better."

Flying, I decided, is nine parts state of mind. Since then, at times, I have been almost willing to believe that flying is entirely mental. It certainly takes no strength—a child of five could work the controls. I have heard it expressed another way; that a good flyer flies with the seat of his pants. In many cases—mine, for example—the stomach seems to be the seat of the flying instinct. Tense stomach—bad flying. Relaxed stomach—good flying.

Jordanoff suddenly said: "I will now upset our balance and you will restore it."

His hand had been off the stick in the forward cockpit. Now the duplicate in my hand began doing things. It went forward and came back and waggled from side to side. The ship began bouncing about. The horizon seesawed and reeled. The nose suddenly shot up and the right wings dipped down.

Jordanoff: "Put us back where we were."

I tried to remain relaxed as I took the stick. I tilted it to the left to bring the right wings up, and forward to put the nose down. But the horizon was still sliding rapidly to the left. I gave the right pedal a touch. That corrected the slip. We were now flying smoothly and straight.

Jordanoff used a plane which happened to be landing to illustrate to me some of the finer points of piloting.

Jordanoff said: "I will take the controls again. With a very light touch, follow me. We will try some easy turns. A left turn first. Observe that I will bank first, then put on left rudder. Notice how little rudder is required for making an easy turn."

I obeyed. The stick tilted ever so little to the left. I felt the left pedal move forward perhaps a half inch. The plane was tilting and turning. For every left turn he made, Jordanoff made a right turn. He said:

"ONE of the worst mistakes some of the old flyers made was in learning to turn only in one direction. They became left-handed or right-handed flyers, depending on the direction of turn that came easier for them. Guard against that. Later on you will learn acrobatics and it will be necessary for you to make left or right turns with equal ease. Take the controls. Try a right turn."

I took the stick. I tilted it to the right. Remembering how I had sent the ship into a bad skid by giving her too much rudder, I touched the right pedal lightly.

I looked down the right wings. They were banked much more steeply than Jordanoff had banked them, and it seemed to me we were not turning as rapidly as we should.

Jordanoff asked: "Do you feel a draft of wind on your right cheek?"

I did. He looked back. I nodded.

"You are side-slipping. Too much bank, not enough rudder. More rudder."

I pushed the right rudder hard. The draft on my right cheek stopped. We continued to turn. I now felt a draft on my left cheek.

JORDANOFF: "Now you are slipping the other way. Too much rudder and not enough bank. Straighten out and make a left turn. Easier! You must roll smoothly out of all turns. If you don't do it smoothly, you will find yourself skidding this way and that."

I tried to do it more smoothly. There were so many things to remember in a turn: the correct bank, the correct amount of rudder, and the correct position of the nose on the horizon. Too much bank—side slip. Too much rudder—side slip. Nose too high—stall. Nose too low—dive. Roll out smoothly—or skid.

I began to perspire. I began to get mad again. Was everybody so dumb their first few lessons? Yes—everybody was, but that didn't make me any happier.

For every left turn, I made a right. I made perhaps six of each.

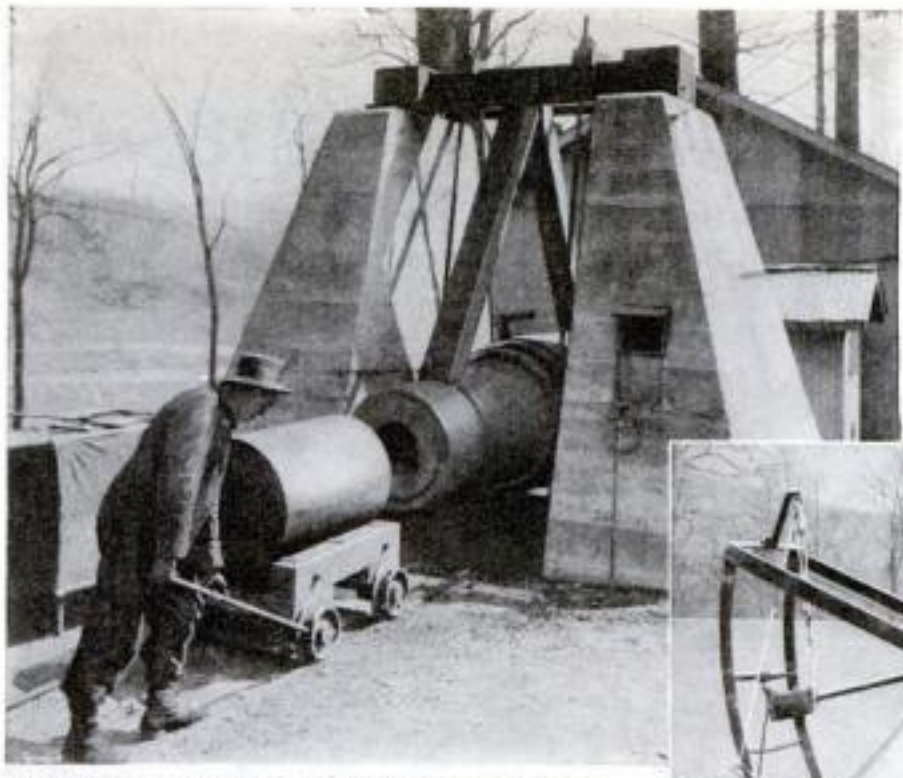
Then Jordanoff told me to fly straight, to pick some object on the horizon and fly for it. I picked a church steeple. But I could not keep the ship steady now, no matter how I relaxed.

We had been up fifty minutes: I had had enough. Jordanoff took the controls. In my maneuvering we had lost altitude. Without my realizing it, the ground had sneaked up 800 feet—we had dropped from 1,000 to 200.

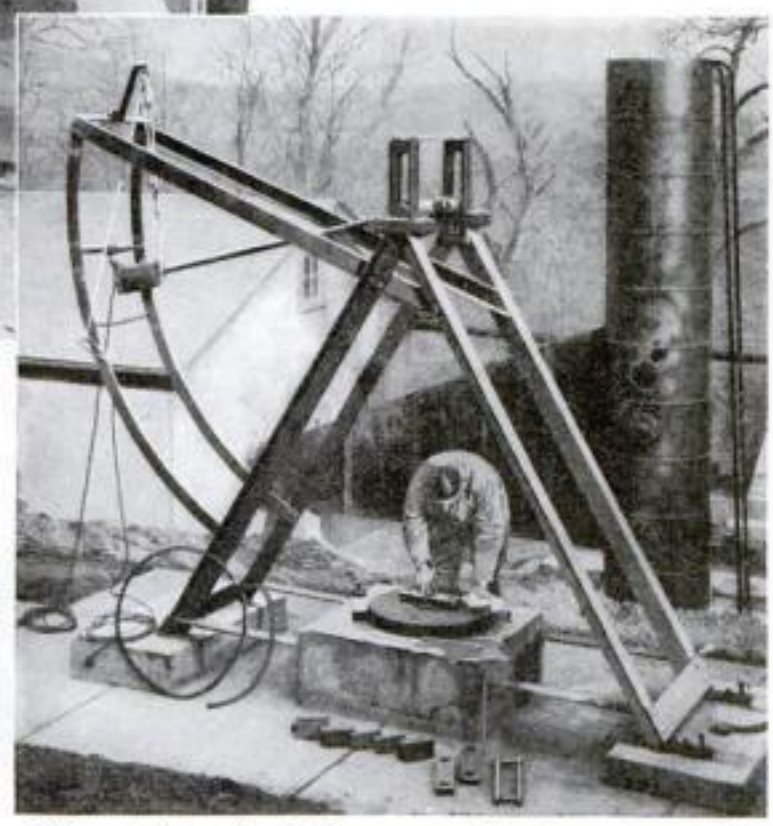
Jordanoff opened the throttle with the intention of climbing when—suddenly—it happened. The motor began to sputter. It sputtered, then, with a snort, it roared again. (*Continued on page 140*)

Jordanoff had told me to hold the stick lig tly, between thumb and forefinger. Every night I practiced this with a piece of broom handle.

Play Tag with Dynamite!



Preparing to fire a cannon-load of explosive to test its strength against a swinging mortar.



This machine tells whether an explosive is easily set off by friction. A falling pendulum scrapes it repeatedly.

IF YOU had the job of handling fifty-seven varieties of death in a day, could you keep your nerve? Could you avoid the one mistake that might blast you to kingdom come? Here is the thrilling story of experts who risk their lives to make high explosives safer for everyone to use.

By EDWIN KETCHUM

CANNONS boom and underground blasts rock the earth at one of the world's strangest laboratories—the U. S. Bureau of Mines' experimental station at Bruceton, Pa. Here "explosive engineers" risk death a dozen times a day, handling nitroglycerin and deadlier substances, in an effort to find a **blasting agent that miners, farmers, and highway engineers may use in safety.**

No one blasting powder will fill the bill. Coal miners want an explosive that is proof against a fatal blast when mine gas seeps through the shafts or coal dust powders the rock shelves. Farmers need a different type, that will enlarge a hole for tree planting and leave fissures for the growing tree's roots; or, if they are stump-pulling, a charge that will blow the stump up out of the ground. Engineers desire an explosive that will gently push out earth for a tunnel, rather than one that will shatter a mountain.

For varied purposes, chemists are constantly devising new mixtures of unknown violence. It is to test these new-born titans, as well as to find the best ways of handling old standbys like dynamite and nitroglycerin, that the Bureau of Mines maintains its extraordinary research station.

In a turretlike "ballistic pendulum," a massive affair of steel and cement, is determined the strength of a new explosive. A research engineer weighs out a pound of the powder, places it in a small wheeled cannon on a truck, and tamps the charge with dry clay. Then the cannon is wheeled up face to face with the "pendulum," an old coast artillery mortar weighing 31,600 pounds. Stirrups suspend the mortar from a steel beam that swings on nickel-steel edges.

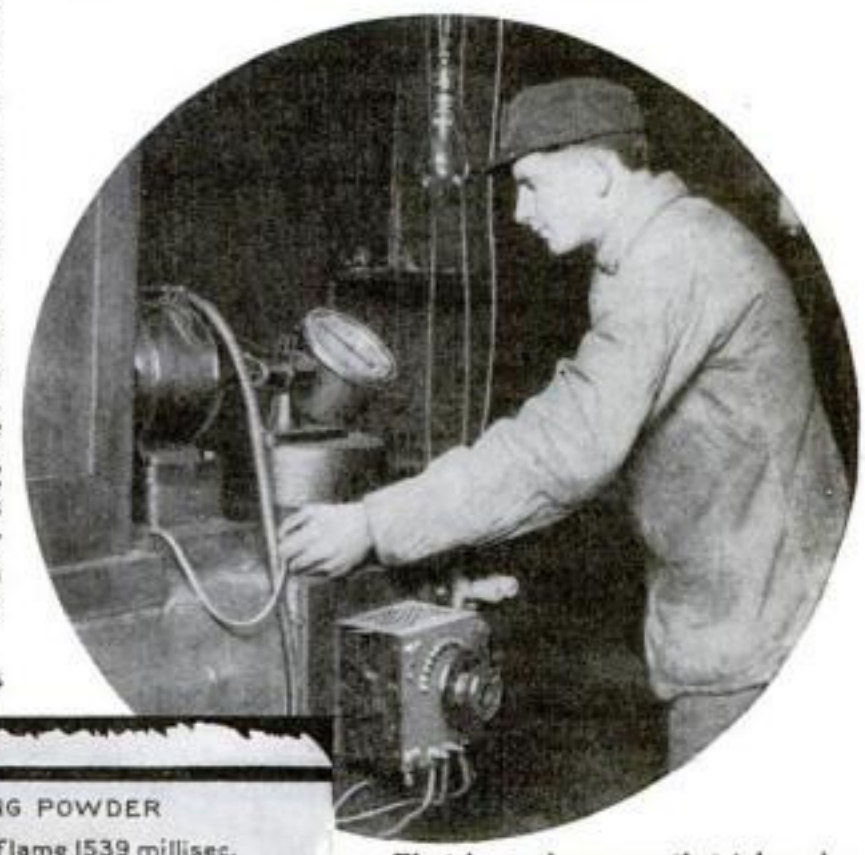
AT A SIGNAL the cannon is fired, straight into the mouth of the hanging mortar. The cannon leaps backward along the rails. Meanwhile the sixteen-ton pendulum rocks upon its concrete piers, the length of its swing measuring the force of the blast.

A different type of pendulum measures the safety of an explosive against preignition by friction or careless handling. For this test, a technician spreads a quarter-ounce of the explosive upon a cross-grooved plate at the base of the apparatus. Then he steps back to a safe distance and pulls a trip cord. Down swings a pendulum arm, faced with a friction shoe of fiber, from a height of nearly five feet. It scrapes again and again across the explosive powder, propelled by a fifty-pound weight. Sometimes the powder explodes; sometimes it doesn't. If no explosion, burning, or crackling occurs in ten of these trials, the explosive passes the test.

Will a powder house containing a new brand of explosive shoot skyward if the concussion of a near-by blast jars it? To find this out, two cartridges are placed a measured distance apart and one is shot off by electricity. If the other fails to fire, it is moved an inch nearer and the experiment repeated. When it finally goes off, its safe distance from a charge of measured strength is determined. A cannon shot of explosive fired into a long steel tube or "gallery" tries out the explosive's tendency to ignite gas or dust. Shelves in the gallery are sprinkled with coal dust.

A novel movie camera photographs explosion flames to compare the safety of different types of explosives. Fast-moving films record the length and duration of the flame, though it is all over so quickly that no eye could follow it. In recent research movies of the spread of a cannon blast through a dust-filled gallery have been made through heavy plate glass windows. They show the traveling explosion wave and reveal what happens when it hits the dust.

Many tests are carried on in an experimental mine in a near-by hill, where to date more than a thousand explosions have been set off. Others are made in "bombproof" dugouts of concrete that look like war-time fortifications. They are a reminder of the hazard that constantly menaces the engineers who make explosives safer for others.



Electric movie camera that takes pictures of an explosion's spread. Left: Actual photo of an explosion flame.

Do Birds Fly by Radio Compass?

A flock of ducks flying over Maryland on their springtime journey north. The newest theory is that they find their way by the earth's magnetic lines, much as airplane pilots follow radio beams.

Amazing New Facts about the Feathered Pilots Who Chart Their Way Over Thousands of Miles

By MICHEL MOK

The Arctic tern, champion long-distance flyer. It flies 22,000 miles a year between its summer home near the North Pole and winter home in the Antarctic; one-way trip takes ten weeks.

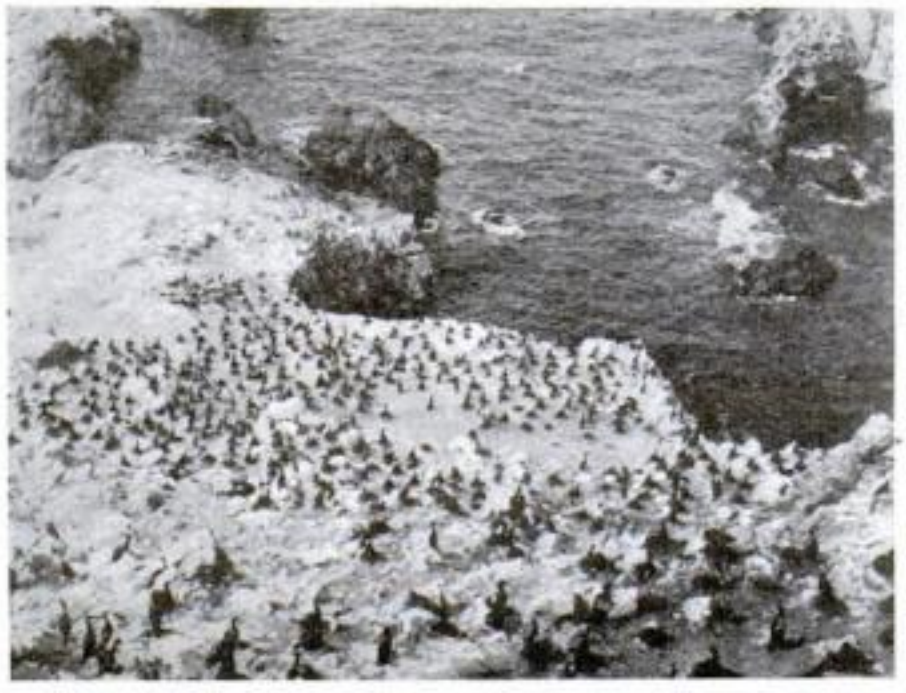
A FEW weeks ago, the House of Representatives at Washington passed a law, previously adopted by the Senate, setting aside at least 125 extensive areas as sanctuaries for the vast flocks of migratory birds that sweep across the North American continent twice a year, and calling for large appropriations to establish and maintain them. The President signed the measure and it became effective.

Thus Uncle Sam took the birds under his wing, and the protection of millions of feathered creatures which make the United States their home part of the year became definitely a matter of Government concern.

This measure once more focused public attention on the always baffling mystery of the migratory mass movements of the flying legions which, each spring and autumn, wing their way north and south for thousands of miles and find their far-flung breeding and feeding grounds of previous seasons with never failing sense of direction.

Why do birds migrate? How do they know when to leave and when to return? What guides the scarlet tanager from Canada to Peru and the nighthawk from the Yukon to the pampas of the Argentine? How does the robin find its way back to the identical pear tree it nested in the year before? How can a humming bird, no larger than my thumb, steer a straight course over 500 miles of rolling water in a single flight across the Gulf of Mexico?

Two hundred years of patient observation have given new answers for these ancient mysteries. Some of the startling new suggestions of science which may at last solve the riddle were told to me the other day by John T. Nichols, of the American Museum of Natural History, New York City. For many years, Mr. Nichols has studied birds and their habits. He is recognized as a leading authority on the subject.



Each spring great flocks of birds build nests on Farallon Island, the Government bird refuge in the Pacific, near San Francisco, Ca.if.

ON THAT very day newspaper dispatches had told of an amazing example of the uncanny ability of birds to chart their courses along the unmarked highways of the sky. A Swedish naturalist, Bengt Berg, trained a flock of wild geese to eat from his hand. The next spring he saw a large "V" of geese high in the air, flying toward him. They descended and came to him to be fed. How could these birds, flying probably from the Nile in Africa, return to the exact spot on the coast of Sweden they had inhabited the year before?

In explanation, Mr. Nichols offered a hypothesis that startled me by its novelty and boldness. Tiny "radio compasses," perhaps located in the brains of the birds, that catch and record electromagnetic lines of force between the north and south magnetic poles, he said, may unerringly pilot the winged wanderers on their great semiannual flights.

I had asked him whether he thought it possible that these flying flocks were guided by high air currents which the birds might follow like mariners tracing the course of the Gulf Stream.

"It is possible, yes," he told me; "but it is more likely that Nature has endowed the birds with some innate electromagnetic quality that enables them to set their courses by magnetism, just as aviators can follow the line of a radio beam projected from a certain point. The human flyer is kept in the lane of the radio beam by the signals caught by his receiver. Some kind of natural 'radio compass' may do the same thing for the birds.

"However," he added, "this idea really belongs in the field of philosophy, which deals with theories, and not in that of science, which recognizes only facts."

Migrating geese in V-shaped flying formation. Left: A flock of birds landing on the Atlantic coast along one of the much-traveled migration "flyways."

A squadron of sandpipers skimming close to the water. These birds fly to the Antilles of South America each fall, and return north again in the spring.

IF THE "radio compass" theory should prove to be correct, it would revolutionize the entire study of bird migration. It would explain why birds can maintain their aerial courses through thick and foggy weather, how the golden plover guides its flight from Nova Scotia to Venezuela, 2,400 miles over water and out of sight of land, and why storms fail to divert birds of passage from their routes. It also would explain how they keep to established "flyways." Ornithologists have long known that migrating birds each year follow the same highways of the sky. One of these "flyways" runs down the Atlantic Coast, another along the Pacific Coast; others follow the Mississippi Valley and cross the Gulf of Mexico.

However, one puzzle is not cleared up by the "radio compass" theory. That is the mystery of the homing pigeon's ability to find its loft, even if freed as far as 1,500 miles from home, and regardless of the compass direction of its flight.

"Some investigators have suggested a special flying instinct or sixth sense as the secret of the directive powers of birds of passage," Mr. Nichols said. "But this is accepted by few scientists today. The majority incline to the belief that habit, location, memory, and association guide them on their long trips.

"A few years ago, the theory that the warmth of air currents plays an important part in steering them over land and sea was popular. You see, warm rising columns of air are found over about half the earth's surface. They are closely connected and, as a rule, move in an orderly manner. According to this notion, the birds, keenly sensitive to changes in temperature, could find these columns and, once in them, could easily sail with or against them at will. But this theory is pretty well exploded now, along with many others. I favor the idea that the seasons hold the key to the old direction mystery."

"THE seasons?"

"Look," he explained. "On their southward trip in the autumn, the golden plovers, for instance, use flyways that are almost wholly over water on their journey to South America. And in the spring, they return north over land by way of Central America. This is clearly because the seasons lag over the sea. In the fall, temperatures drop more rapidly on the continent than they do over the ocean. In the spring, the air over the land warms more readily than the atmosphere over the water. That, I think, is the reason why many migratory birds go south by water routes and come back by way of the Isthmus of Panama and Mexico."

Bank swallows off for their journey to the coast of South America. Their cousin, the chimney swift, flies to the Gulf of Mexico and vanishes!

Observations by ornithologists the world over bear out this view. It is a well-established fact that the movements of the average minimum temperature, which naturalists call the "frost line," are the signals for the migrant's semiannual departure and return.

As soon as their summer breeding and molting activities are over and the days begin to

(Continued on page 149)

The Man Who Made Radio Talk

And Gave the Movies a Voice—The Dramatic Story of Lee De Forest, Inventor of the Audion Tube

By FRANK PARKER STOCKBRIDGE

AN EAGER-MINDED boy, compelled by circumstances to suppress most of a boy's natural outlets for his energy.

A keen-minded, diffident youth, with nothing in common with his schoolmates, thrown back upon his own resources in his effort to fit himself for life.

A shy, introspective college student, unable to express himself among his fellows in any manner but through his work in classroom and laboratory.

A visionary young man, fired with inspiration through reading of Tesla's and Marconi's experiments with the Hertzian waves, seeking—and finding—a better way to make the wireless telegraph work.

An "impractical" inventor, easily preyed upon by unscrupulous promoters, betrayed by friends, sneered at by rival inventors, his patents infringed by others, disheartened, baffled, almost beaten by the world which he had never learned how to fight.

Then, suddenly, the wheel turns and Lee De Forest is sitting on top of the world.

He made the wireless speak!

Modern radio, as we know it, springs from De Forest's audion tube. It made voice transmission and therefore modern broadcasting possible and practical. Applied to the wires, it is the foundation of all long-distance telephony. It has turned the world of communications upside down.

Two weeks ago, as this is written, the Supreme Court of the United States officially proclaimed Lee De Forest the "daddy" of modern radio. The highest tribunal in the land at last upheld his basic patents on the audion tube in its applications as a radio detector, a radio amplifier, an oscillator, and a regenerator in receiving sets.

TO THE spare, kindly, gentle-voiced, gray-haired man with whom I talked in his laboratory in New York, this belated confirmation of his pioneer claims came as no surprise. There is a simple faith about Lee De Forest's outlook on life, a faith based upon the belief that somehow, sometime, every man gets what he deserves. He knew he was right, and was not in the least elated when the nine great jurists on the bench in Washington agreed with him. In his matured philosophy of life, the world's acclaim means nothing to him. Except as the Supreme Court's decision pours millions in deferred royalties into his pocket—millions for which he has no personal love nor need—he is all through with radio.

All of Lee De Forest's interests today are in the movies. For, just as he taught the radio how to talk, he has given the motion picture a voice.

The De Forest phonofilm is the parent of the "talkies," as his audion tube is of broadcasting. Others have discovered the ways of accomplishing the same or similar results, but it was Lee De Forest's original conception of photographing sound on the same film which carries the picture which has revolutionized the art of the cinema.

I submit that Edison himself, at fifty-five—De Forest's present age—had hardly achieved anything more far-reaching than these two accomplishments, of making the radio and the movies talk.

I found it almost as hard to get De Forest to talk as he had found it to coax them into speech. Sitting at his desk in the big building which was designed as a studio for Norma Talmadge's motion picture productions, he overcame his diffidence sufficiently, however, to give me the high-lights of an inventor's methods and to indulge in a bit of forecasting of the future possibilities in his fields of work.

The invention of the audion tube was no accident. Like most great inventions, it came about because a man of vision and imagination, familiar with the technique in the field of his labors, saw an unfilled need and set about to find a way to fill it. As a post-graduate student at the Sheffield Scientific School at Yale, the youthful De Forest, having recognized the need of a better way of detecting wireless waves than Marconi had found, devoted the next half-dozen years to the pursuit of that way, until he found it.

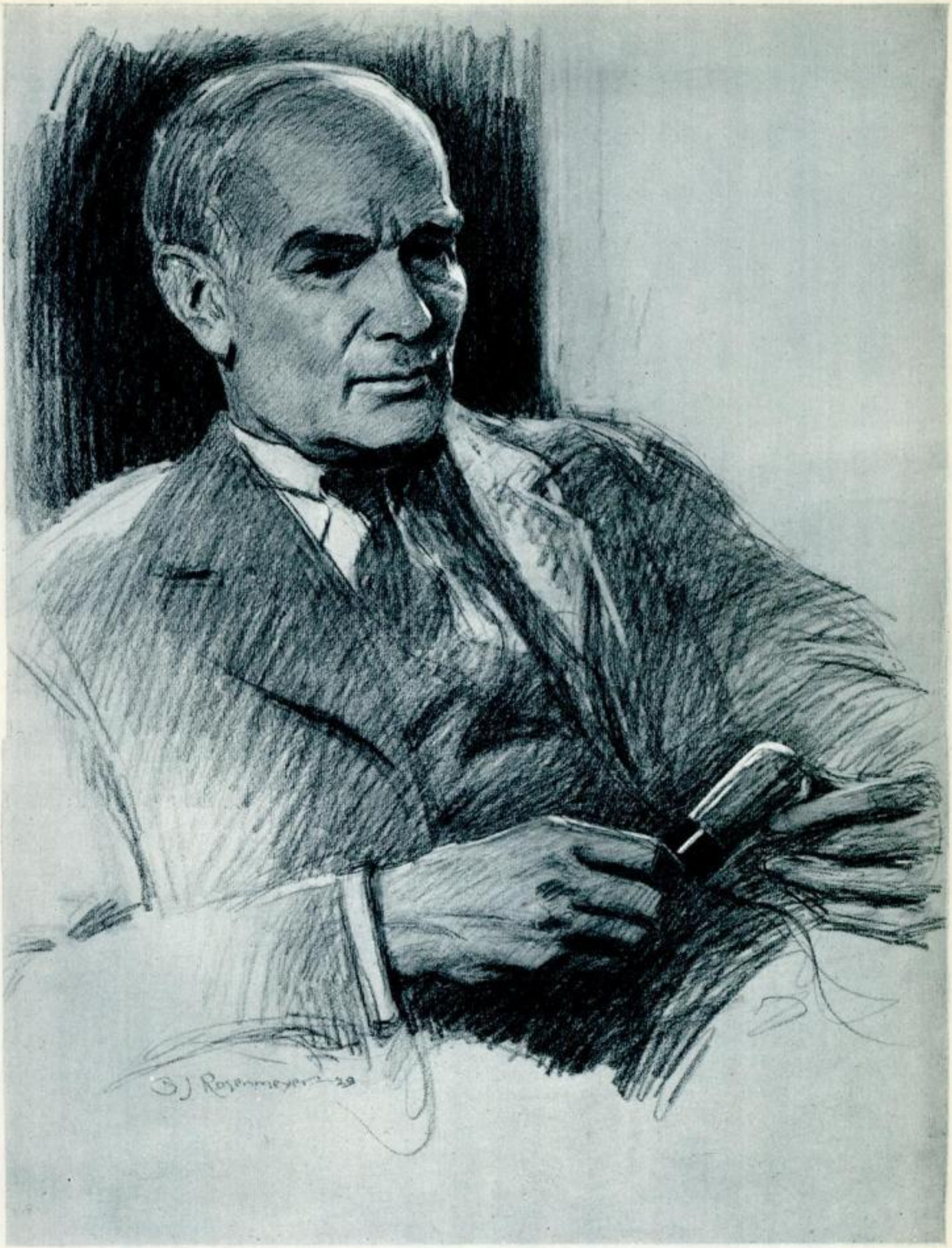
That was his sole recreation as a boy and a young man—the pursuit of knowledge. Born on August 26, 1873, in Council Bluffs, Iowa, where his father was a Congregational minister, he was taken as a boy of six to Talladega, Alabama, where his father became the head of one of the earliest colleges for negroes.

"IT WAS a difficult environment for a boy," De Forest told me. "I could not associate with the negro children on terms of equality, and the children of the white families in the town were not permitted to associate with me, because my father was committing the then unpardonable crime, in Southern eyes, of educating negroes. My brother and sister and myself, and the few other children of white teachers of the college, had to build up a little social system of our own, which was too narrow and limited to be good for us. Out of such an environment a boy grows up either arrogant or diffident. He has had no opportunity to associate with his equals, and feels himself either superior or inferior to all with whom he comes in contact.

"I came through that experience shy, diffident, without knowledge of the world or of life. I had plenty of book knowledge, but none of practical affairs. My father, by the utmost frugality, managed to find enough money to send me to a preparatory school in the North, an obscure, sectarian school at Mount Hermon, Mass., where my schoolmates were farm boys, unfamiliar with the cultural standards of my parents' home but far beyond me in their ability to adjust themselves to the give-and-take of community life. The result was to drive me farther into myself, so that when I finally entered Yale I was probably the most timid, unsocial student who ever went to New Haven."

The course at Yale was achieved only at the cost of a tremendous struggle against this handicap and financial difficulties. Only the inborn American passion for education (*Continued on page 132*)

THE story of Lee De Forest, and of his long and bitter court struggle for possession of the basic patents on the audion tube, runs parallel to the history of radio. Like most great inventors, he has been maligned, ridiculed, baffled—and all but beaten. Even today, when he emerges apparently victorious, vindicated in his claim to be called the father of radio broadcasting, his very name is anathema to many. Here Mr. Stockbridge writes the drama of the timid, unsociable youth who set his face toward a goal and learned how to fight to win it.—The Editor.



Drawn from life especially for POPULAR SCIENCE MONTHLY *by B. J. Rosenmeyer*

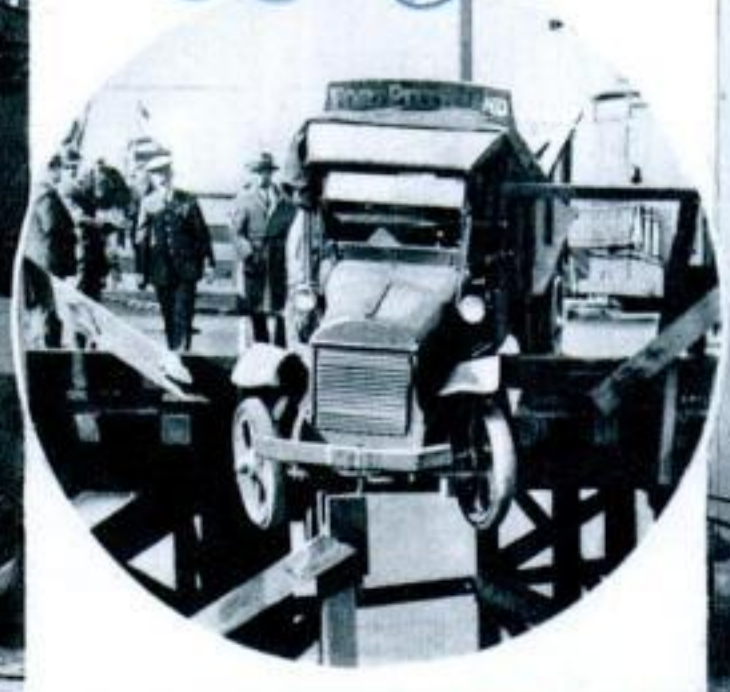
Lee De Forest, Father of Broadcasting

Sole inventor of the three-element vacuum tube, by recent judgment of the highest court in the land, Dr. De Forest stands as the radio pioneer who made practicable wireless communication beyond the limited field of code telegraphy and so gave the world broadcasting of speech, music, and entertainment. He also was the first to record sound on a motion picture film.

Hanging by an Eyelash!

The Fence Held

A few thin bands of iron were all that saved this delivery car from a twenty-foot plunge over the brink, when it skidded and waltzed across icy pavement of a viaduct at Jersey City, N. J. The rear wheels tore a section of the iron fence from its foundation and went clear off the edge. There the car teetered precariously above the street — but the fence held.



Was He Scared?

The driver of the truck pictured above owes his life to a two-ton load of sand it was carrying. Turning sharply to avoid hitting an automobile on a drawbridge across the Harlem River, New York City, the machine struck a pillar, plunged through a guard-rail, and hung over empty air, anchored only by the weight of the sand. The picture in the circle shows a similar breath-taking experience of another truck after a collision with an automobile on Manchester Bridge, Pittsburgh, Pa.

Right Through the Wall

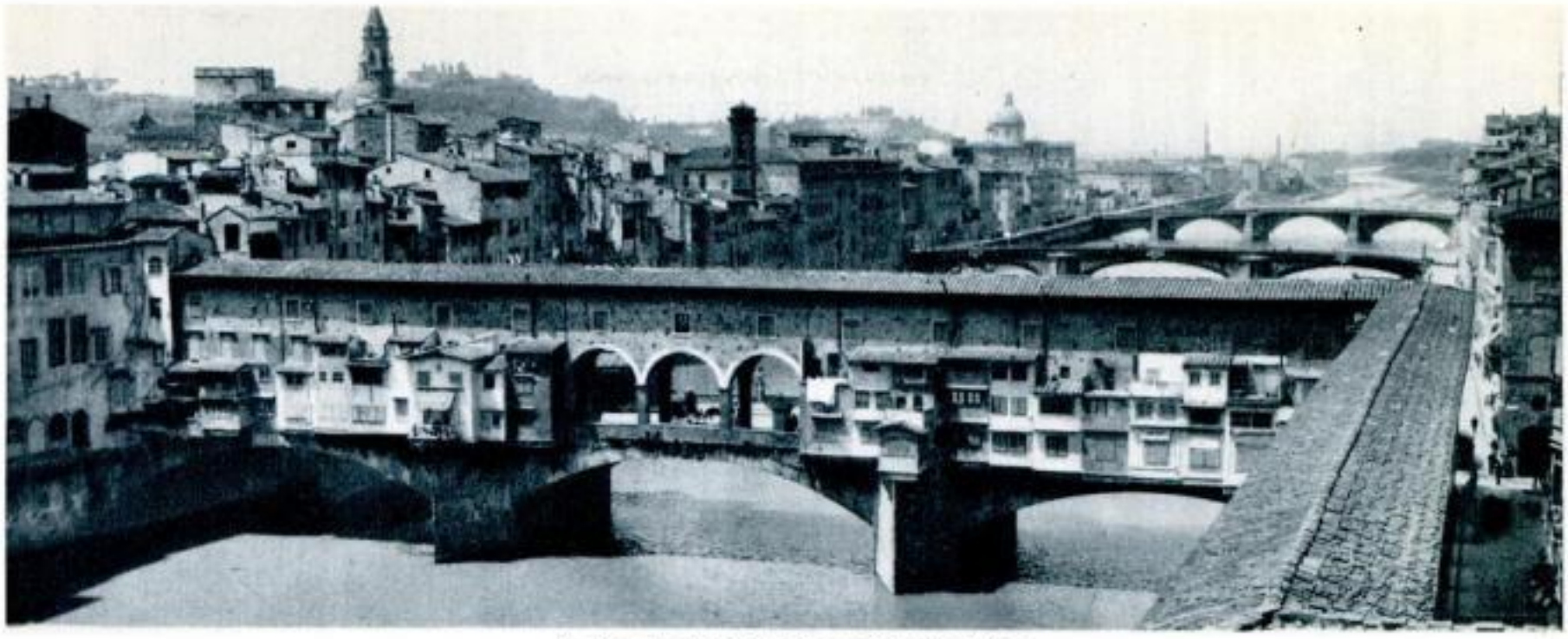
After crashing through a thick stone wall, this big coal truck came to a stop with its nose out over the edge of a New York City viaduct. Only the fact that its rear wheels were held fast in the shattered masonry prevented disaster.

Three Inches to Go!

Just three inches more, and this fire truck would have dived over a fifty-foot bluff in New York City. A skid did it. The machine below just missed jumping off a bridge at Germantown, Pa.

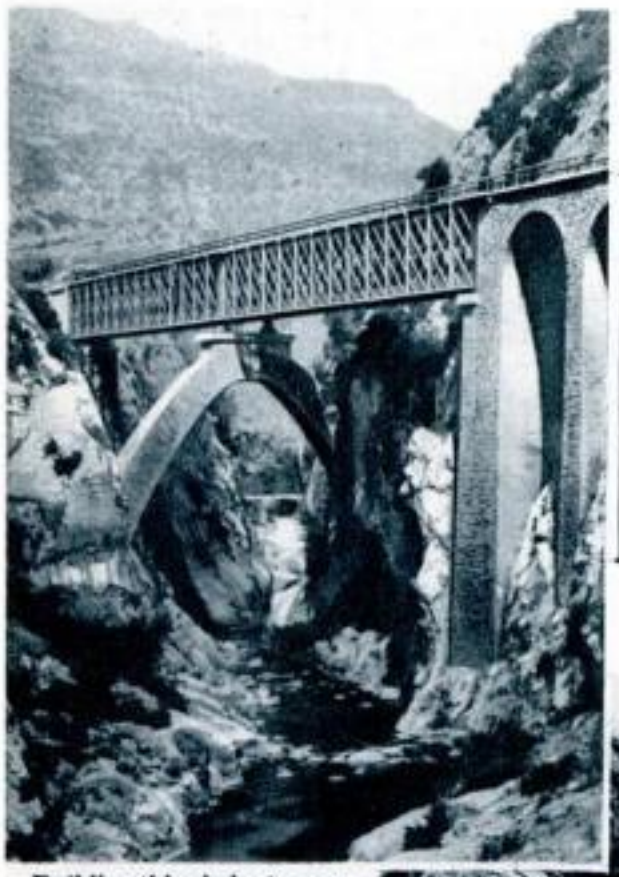
It Might Have Been Worse

Another close call, at the approach to a Harlem River bridge. To avoid possibility of such accidents, many of the highways now are bordered by heavy steel cables or netting wherever high embankments or sharp turns offer greatest danger.



A shopping district is housed in the Ponte Vecchio, over the Arno River at Florence, Italy. The roofed bridge is lined with stores.

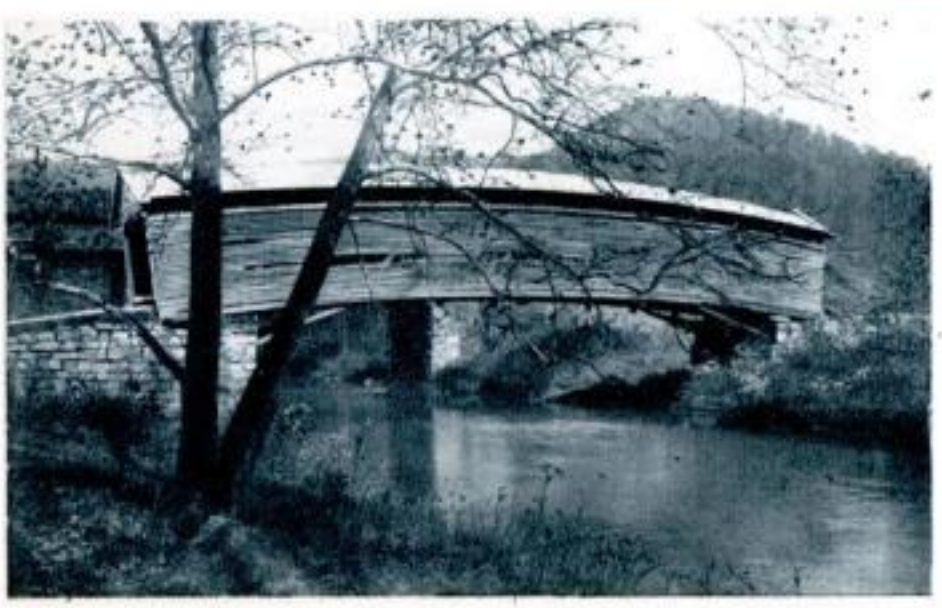
Strange Bridges



Building this viaduct across the gorge of a small stream near Nice, France, engineers saw that a central vertical support would clog the gorge. So they devised an unusual masonry arch support set at right angles to the span.

Natives of Yunnan province, China, built this sturdy suspension bridge of tough wistaria vines, proving the plant useful for more than its flowers.

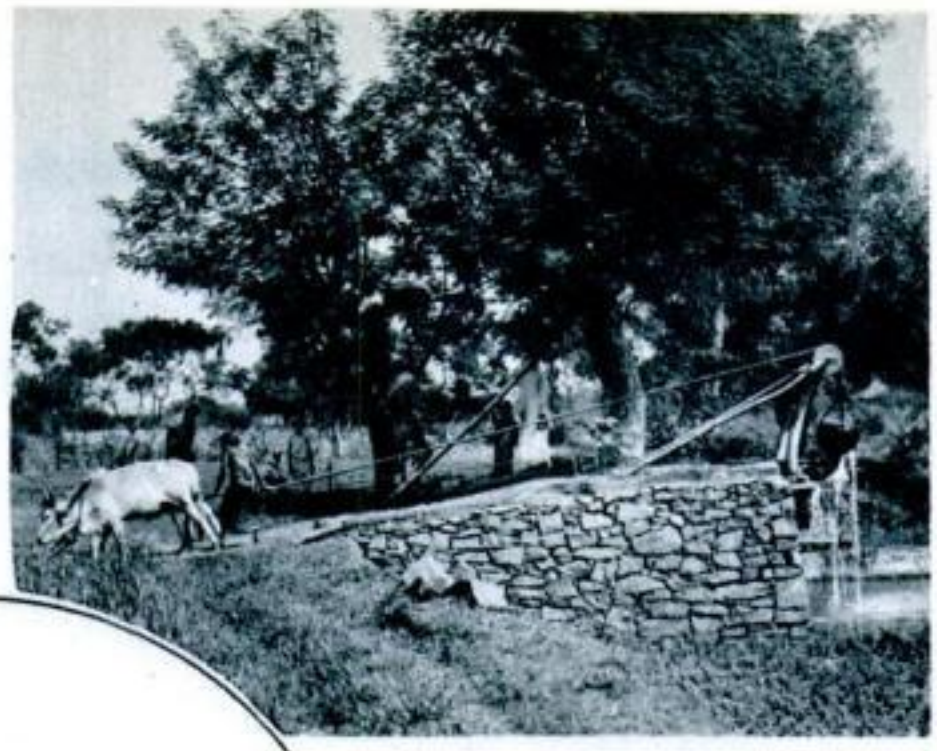
On the grounds of the Summer Palace of former Chinese rulers at Peking stands this ornate bridge, humped like a camel.



The covered bridge, like the covered wagon, has all but vanished in America. Here is one of the last of the line, battered by the ravages of time but still creaking under traffic three miles from Covington, Va.

You couldn't jump from this bridge if you tried. Savages in jungle country of India built it across a swift-moving mountain stream, using homemade ropes for the main cables, interwoven with withes.

It's a far cry from the electric pumping machines on modern farms to this primitive pump worked by a revolving camel at a desert water hole in Egypt. Note the crude gearing. Projecting wooden-pins in one wheel engage rods in the other.



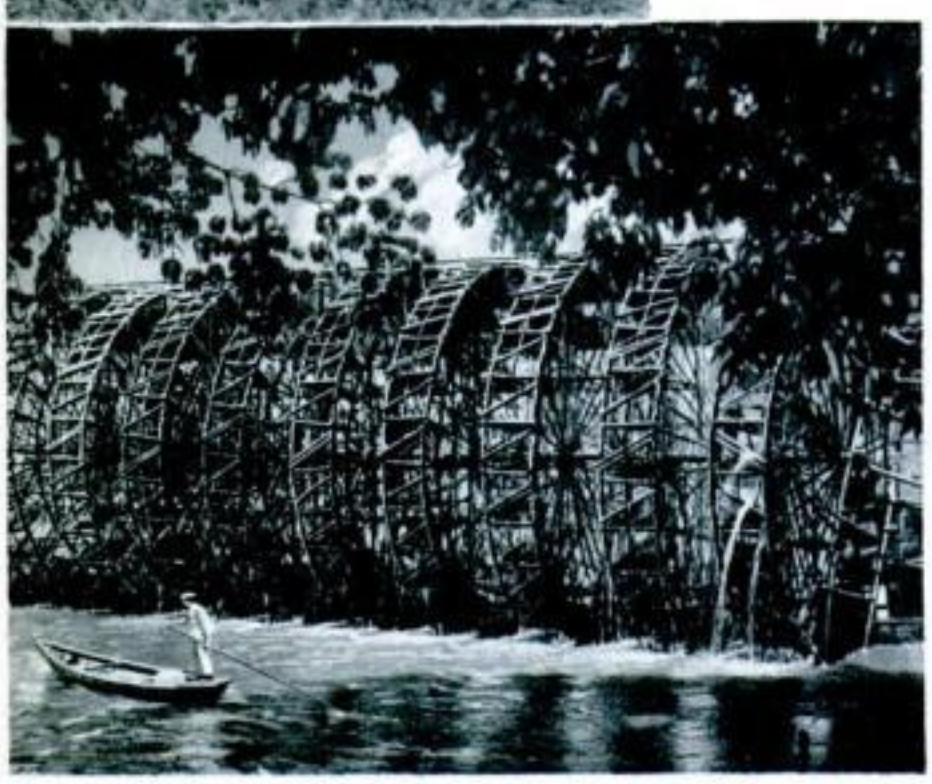
Down on the farm at Trichinopoly, southern India, they have no running water, garden hose, nor sprinkler. So they hitch the cow to a crude derrick that lifts water in a bucket from a pool to the level of the field for irrigation.

Watering the World's Crops

HOW the world has advanced in machinery for drawing water for farms and gardens is told here in pictures from many lands.

To irrigate their paddy fields, Chinese families in the Soochow region work the treadmill for hours, as shown at left.

Right: A Siamese woman gets her daily exercise by working a treadmill irrigation pump in the rice fields. Compare this primitive machinery with huge modern irrigation dam below

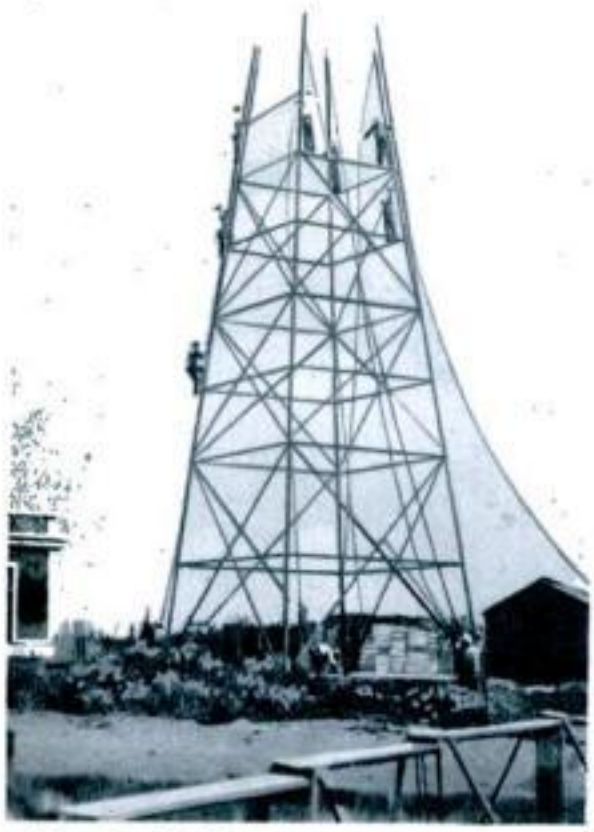


A primitive "super-power" irrigation plant at Ouang Ngai, in Annam province of French Indo-China. A battery of huge bamboo water wheels, revolving side by side in the same stream, supply irrigation for a large farm near by. The running stream passes through a series of sluices to drive the light wheels, whose power pumps the water to a higher level. An ingenious machine, but a far cry from the modern way, at right.

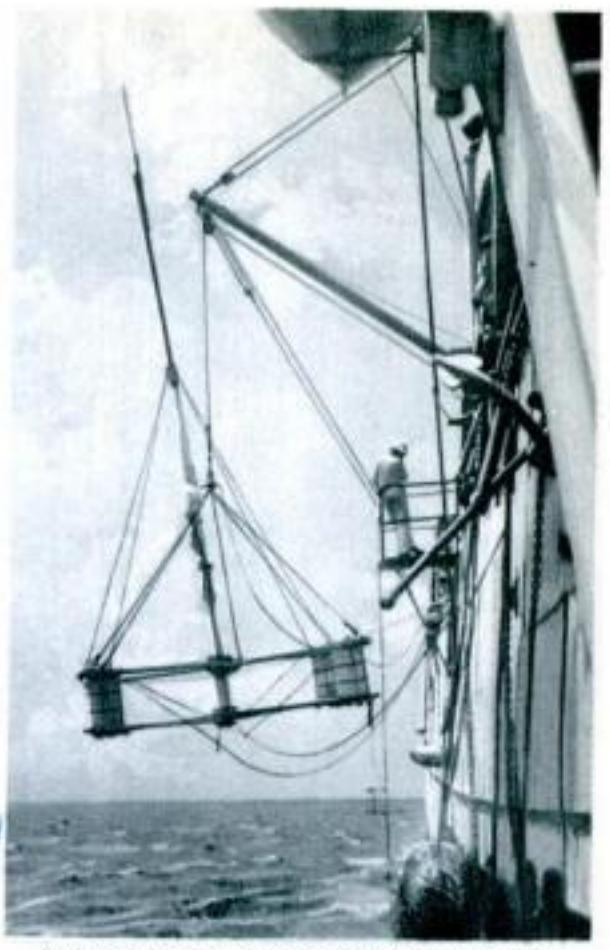
The modern way—the great Roosevelt irrigation dam in the Salt River Valley, Arizona. Its waters have reclaimed more than 200,000 acres of arid land, once the abode of rattlesnakes, and have built a rich agricultural region, with half a dozen thriving towns. The dam is 284 feet high and 1,080 feet long. Its storage capacity is 533,000 million gallons. It was built by the U. S. Government in 1911, at a cost of $3,890,000.

Making New Maps of the Sea

WADING waist-deep in alligator-infested waters, battling the raging surf in small boats, piercing the jungles, or climbing mountains with heavy instruments—it's all in the day's work for the U. S. Naval Hydrographic engineers who, with the steamers *Hannibal*, *Niagara*, and *Nokomis*, are charting anew the shores of Central America and the West Indies, mapping dangerous reefs and shoals of the Caribbean Sea. On this page are glimpses of the adventurous tasks by which surveyors of the deep are making navigation safer.



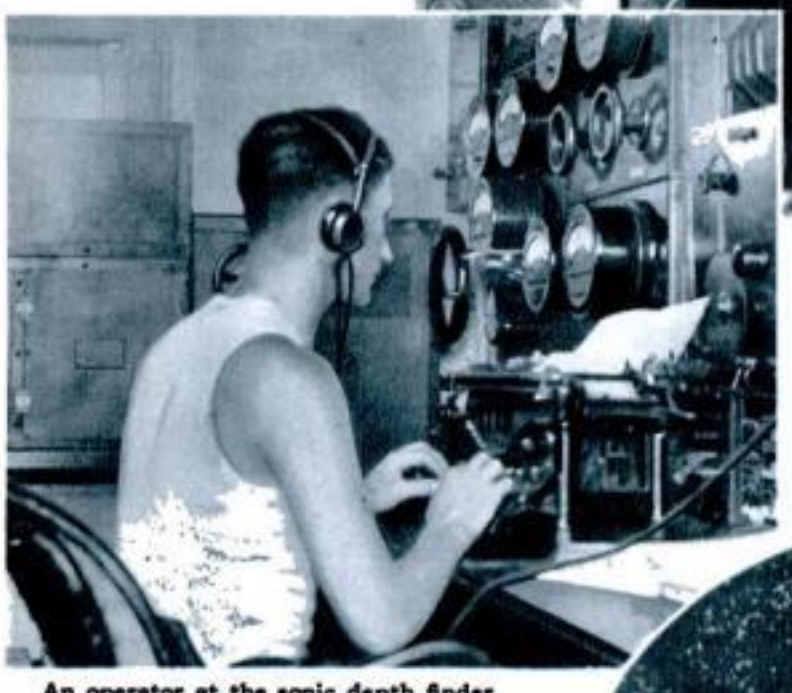
Part of the job of surveying to make accurate maps of a coast line is the erection of lofty signal towers. It calls for the skill and steady nerves of a steeplejack—particularly in the gale-swept regions of the Caribbean.



Lowering a marker for the marine surveyors over the side of one of the Government vessels. This float, with signal mast, is designed to remain upright on the waves.

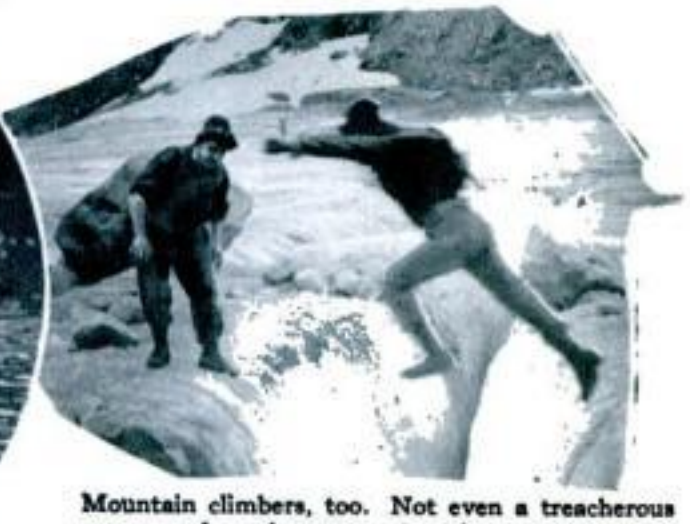
Wind, waves, and spray beat against the engineers in this small craft, crossing a bar on the way out to sea after surveying inshore. To get accurate figures on shore lines and depths, the surveyors often must land their small boats, with their tripods and instruments, on the wave-swept beach.

The old way of measuring the depth of the sea—with a sounding lead at the end of thousands of feet of piano wire. Though still widely used, this apparatus is being replaced by the new sonic depth finder, pictured across the page.



An operator at the sonic depth finder, the new instrument for measuring ocean depths. Sound signals are sent from the bottom of the vessel, and the time required for their echoes to return from the ocean floor and be heard on this receiver tells the depth accurately.

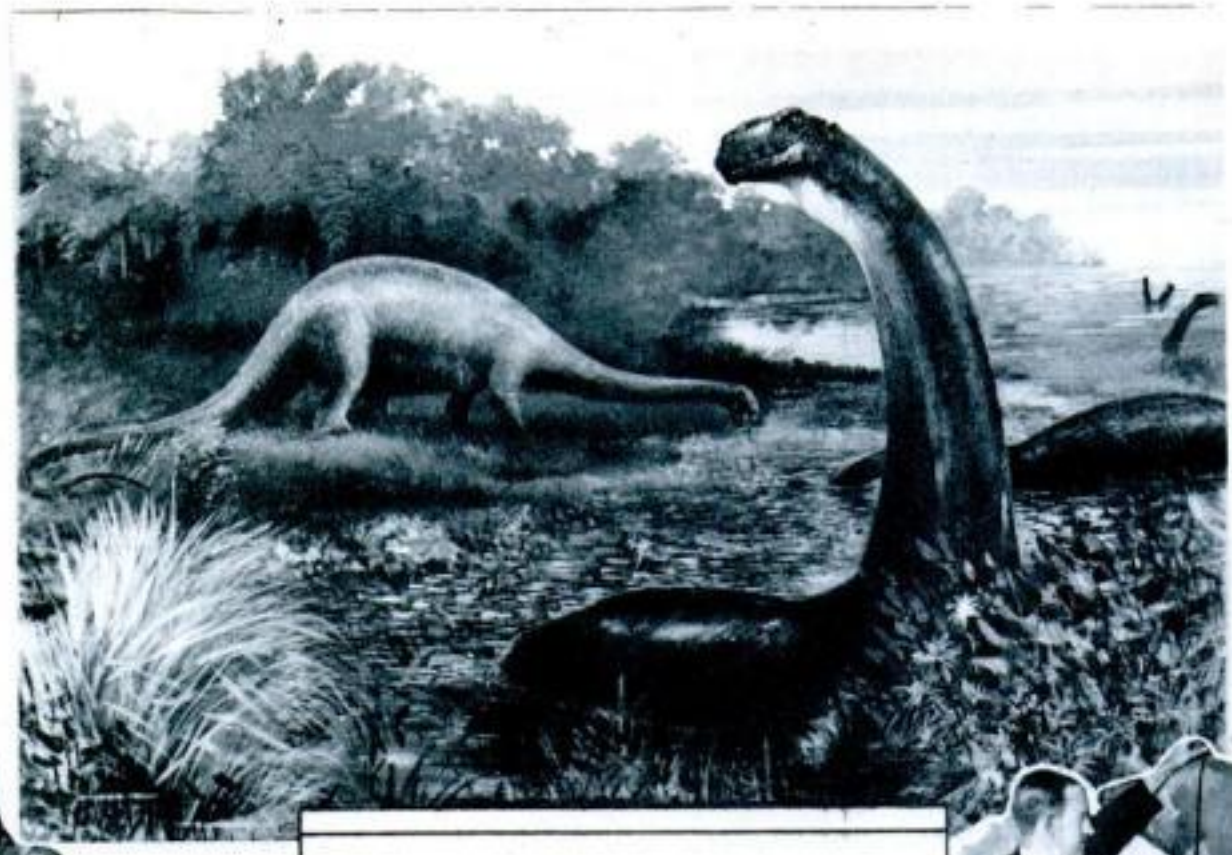
Surveying under difficulties—waist-deep in tropical waters. While one engineer sights his instrument, the other holds up a big umbrella as a shield from the blazing sun, all the time keeping a sharp watch for alligators. Little known shores, once the lair of notorious pirates, thus are being accurately mapped.



Mountain climbers, too. Not even a treacherous crevasse of a volcano can stop the surveyors from getting their figures. No Alpine safety ropes to catch this man, either, if he misjudges his distance in leaping the chasm. It's no job for tenderfeet.

Bringing Dinosaurs to Life

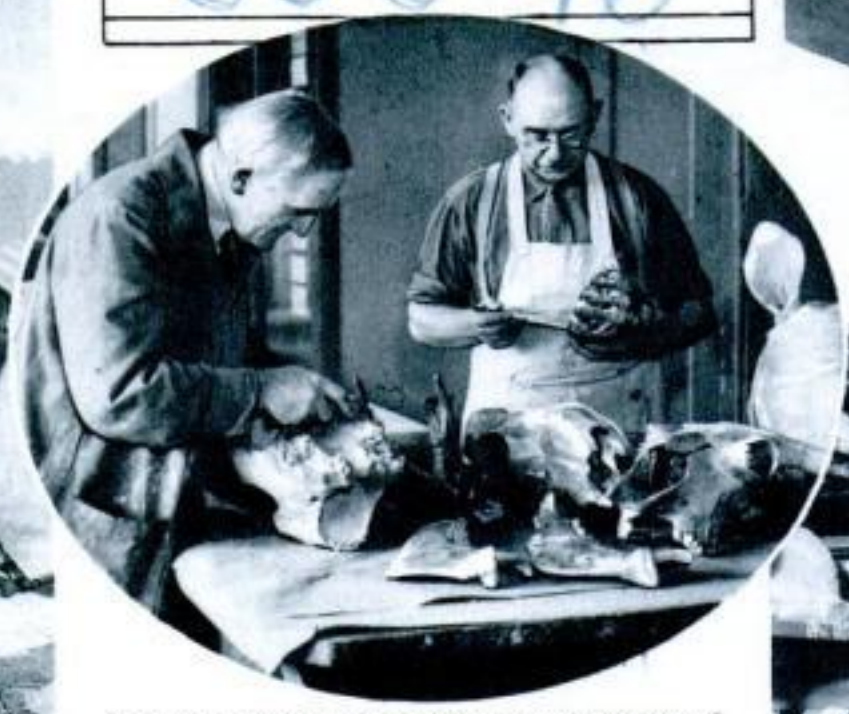
BONES of dinosaurs and other prehistoric monsters, found in all parts of the world, are continually added to the famous collection in the American Museum of Natural History. There they are filed in storage racks, later to be assembled into the skeleton of some strange creature that lived thousands of years ago. Below: Dusting skull of an extinct rhinoceros from Kansas, using a vacuum cleaner.



Before the Rocky Mountains existed and when Colorado was as flat as Kansas, the terrible Brontosauri, or thunder lizards, lived in the western United States. Judging from their bones, this is how they looked, some two million years ago. The largest were twenty-five feet long and twelve feet high.

Measuring one of the largest dinosaur bones in the world, at the American Museum. It is the huge femur, or thigh bone, seventy-one inches long—taller than man standing beside it.

A battle of monsters 3,000,000 years ago. From rocky imprints of dinosaur feet, and from bones, experts reconstructed pose showing the start of the titanic struggle.

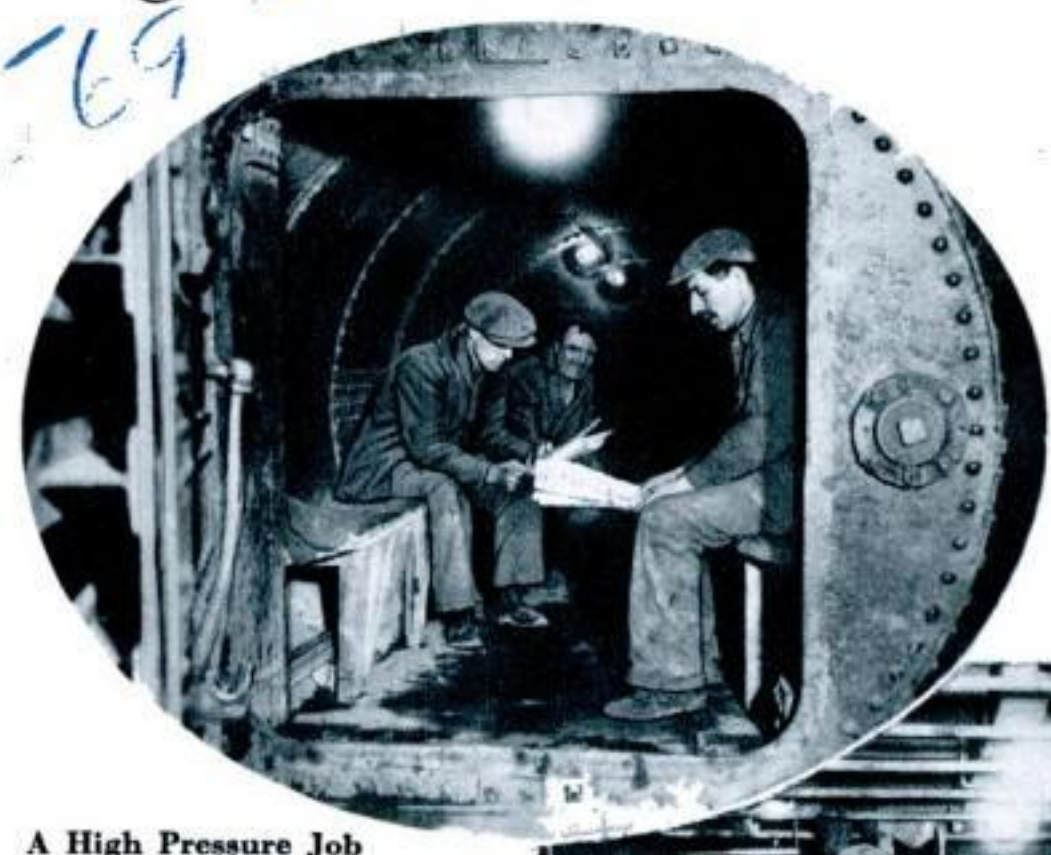


Two of the Museum's experts in the restoration of the bones of past ages—Otto Falkenbach (left) and George Olson—are seen here at their work, dolling up the queer skulls of fossil animals for exhibition.

Scientists themselves gasp in amazement as dinosaurs "come to life" again, pieced together on scaffolding. Here is the skeleton of the thunder lizard, pictured at top of page.

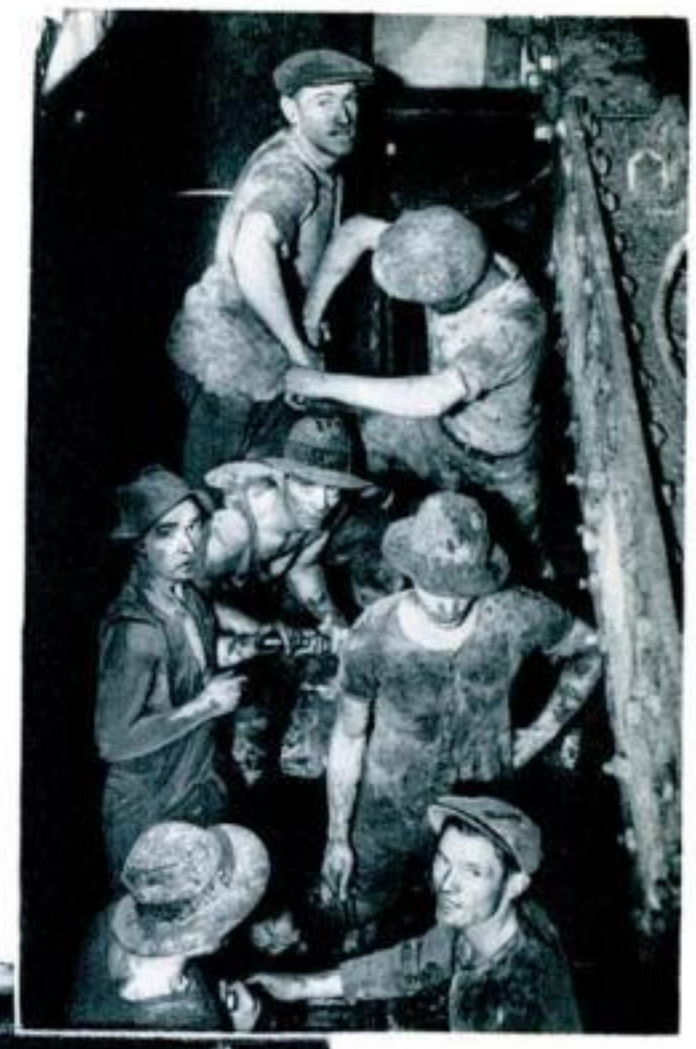
The filing case of prehistoric bones. On the table is the skeleton of the armor-plated dinosaur that once roamed in Colorado and Wyoming. Dr. G. G. Simpson, associate curator of vertebrate paleontology, holds the tail of the monster.

How Human Moles Dig River Tubes



A High Pressure Job

Two hours is a good day's work for the "sand hogs" who, under air pressure three to four times as great as that of the outside atmosphere, are digging two new rapid transit tubes under the East River, New York City. Here is a gang in the air lock, reading while pressure is raised to that of the working chamber.



Close Quarters

Sand hogs bolting one of the huge cast-iron rings that form the shell of the tube. So hot is the working chamber that the men often labor half naked.

On the Front Line

At the nose of the tunnel a huge cutting shield is driven ahead by powerful jacks. These men are seen digging out the loosened material where the shield has penetrated.

The Finished Shell

A section of the completed shell of the tunnel, showing how the rings are fitted together. In the distance is the entrance to the working chamber.

No Weaklings Need Apply

A physician tests the heart of a prospective sand hog after a trial in the pressure chamber. Behind them is the entrance to the air lock, where gradually increasing pressure prevents caisson disease, or "bends."

Bringing Up the Diggings

New York entrance to the tunnels. Dump cars loaded with material are hauled to the surface by electric engines through special air locks.

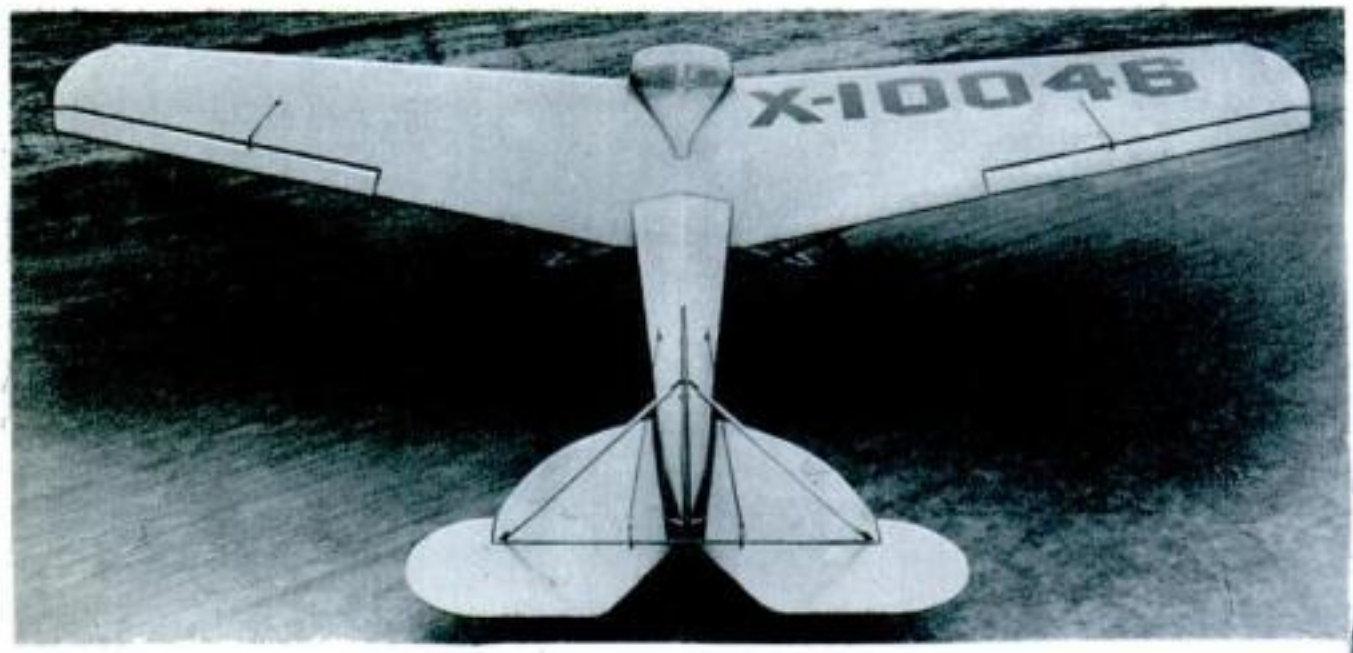
Setting the Pace in Aviation

A Flying Radio Laboratory

In the cabin of a large monoplane, Harry Diamond (left), expert of the Bureau of Standards, runs a laboratory where he tests radios used by pilots for receiving radio beacon signals and weather reports.

The Biggest of Them All?

A plane of ordinary size nestles easily under one wing tip of this mammoth Junkers monoplane recently completed in Germany. It is driven by four motors, and has two pairs of landing wheels.



Called "Fool-Proof"

At the left is the latest attempt to make a "fool-proof" plane. The designer, Fred L. Bronson, of Los Angeles, says auto drivers can fly it. Its wing angle is said to give unusual stability and a landing speed of twenty miles an hour.

For Wind Tunnel Tests

An electrically heated wire, one fifth as thick as a human hair, is used in this Bureau of Standards instrument to measure wind velocities.

Model Propeller Pulls 15 Pounds

A model of a new twin propeller for airplanes demonstrates its efficiency by pulling a toy cart with a fifteen-pound load across the floor. The two propellers, side by side, whirl in opposite directions. This has balancing effect of a gyroscope, the inventor says, eliminating torque or twisting force and increasing pulling power.

All Aboard!

At the right is one of America's newest air liners, the luxurious twenty-passenger monoplane *Patrician*, at Curtiss Field, N. Y. It is driven 130 miles an hour by three 525-horsepower motors.

Building the First Winged Dirigible—Autogiros for America—New Devices for Speed and Safety

WINGED dirigibles, mentioned not long ago by Henry Ford as a worth while possibility in aviation, seem about to become a reality. An English firm has just placed orders in Germany, reports say, for a curious hybrid machine that will be half airplane and half dirigible. It is to have a gas bag of 420,000 cubic feet capacity, making it a full-fledged airship; but a set of wings like those of a plane will extend from the body to help support it in flight and also to facilitate landing, thus eliminating a large ground crew.

Intended for passenger service, the odd 130-foot craft is to carry six passengers, a two-man crew, and mail and baggage. It will be semirigid with a frame of steel tubing. Two motors of only thirty-five horsepower each are expected to give it a cruising speed of sixty miles an hour.

Rubber Airplanes Now!

THE newest structural material for aviation construction is a novel "lumber" made by pressing together two sheets of hard rubber, with an inner layer of sponge rubber between. Already the substance has been used to build motor boats, and now it has entered the airplane field as well.

New Safety Slots

BY THE addition of an automatic locking device, the newest Navy two-seater plane, a speedy Vought Corsair, improves the safety "wing slots" recently developed in England. It is said to be the first plane in America to be equipped with them.

A test pilot at Long Island, N. Y., deliberately put the new plane into a spin, then pressed a release lever that unlocked the slots—a pair of small auxiliary wings mounted above the main ones. The added control surfaces brought the plane out of the spin in half a turn. The lock is an answer to pilots who have objected to the previous automatic type of antispin slots, contending that though in emergency they provide additional control surface, they interfere with aerial acrobatics.

An unforeseen use of the slots is to facilitate landings upon water by enabling planes to slow up without loss of control. Capt. W. R. Maxwell, director of provincial aviation for Ontario, Canada, finds that DeHavilland Moth seaplanes equipped with the slots are preferred by Forest Service pilots. It is hard to judge height above water, they say; and the slots enable a pilot in doubt to flatten out for a landing ten feet above the water and "pancake" or drop flat into it without damage.

An Air Beacon of Steam

A GIGANTIC jet of escaping steam serves as an unusual type of air beacon at a Harrison, N. J., lamp factory. Engineers discovered that when the jet was bathed in the brilliant light of 25,000,000-candlepower floodlights, some green, others blue, red, and amber, the beacon could be seen at night ten miles away. By day the unique beacon is a wind indicator for airmen.

AN AIR mail plane was streaking across the Carson Sink Desert in Nevada recently when one of its passengers snapped this remarkable photograph of the plane's moving shadow on the sands. It tells better than words the new romance of the fast mail, winging its way over vast expanses of our continent. If all the 160,000,000 letters sent by air mail during the last three years were strung end to end, they would form a trail leading nearly around the world. And a postmaster, canceling a letter every second, would have to work day and night for five years to complete stamping the batch!

Autogiros for America

WINGLESS "autogiros" or Cierva windmill planes, which can land in almost any back yard, are to be manufactured in America, according to a recent announcement of Harold F. Pitcairn, president of an eastern aviation firm. They head a list of more than a dozen European types of planes and engines to be made here during 1929 by a number of American firms; indicating that American aviation is shortly to feel a distinct foreign influence.

Savoia-Marchetti seaplanes, used by Francesco di Pinedo in his 1927 tri-continent trans-Atlantic flight, and by Ferrarin and Del Prete last year when those Italian airmen hung up a long-distance flying record that still stands, will be built at Port Washington, N. Y. A $1,000,000 seaplane base is to be included in the project.

Caproni airplanes, among the largest in the world, are to be built by another American firm according to the design of Gianni Caproni, whose bombers were used by the Allies in the war.

The DeHavilland Moth and the Avro Avian, popular small sport planes in England, now are to be made here as well. American machinery also may turn out the giant Dornier and Rohrbach flying boats designed by German firms. Meanwhile, what is termed the largest aeronautical enterprise in America has been launched with the formation of a $200,000,000 aviation corporation. A score of powerful banks and presidents of railroad and steamship firms are backing the new company.

Huge New York Airport

TWELVE minutes from New York City by automobile, and only five minutes away by pneumatic mail tube, an immense airport, to be built in the waste land of the Hackensack, N. J., meadows, is announced by a new $10,000,000 firm. A thousand acres of land have been secured at this writing, and work on the airport is to begin immediately. By early fall, it is expected, the first runways will be ready for use.

An artificial lake of fifty-six acres, for seaplane landings, is a novel feature of the project.

Radio Lights the Airport

WHILE an approaching plane equipped with a siren lit its own airport lights at Newark Airport, N. J., the other day, as is told elsewhere in this issue, another system of remote control was being demonstrated at a Birmingham, Ala., field. It consists of a radio transmitter mounted on a plane.

The approaching pilot operates his radio and an automatic receiver located on the field responds by turning on the lights.

X-Rays Trap Art Counterfeiters

How the New Sleuths of Science Run Down Frauds and Identify the Old Masters by Their "Fingerprints"

By

JOHN E. LODGE

Restoration of an old portrait by Badile, tested by X-rays in Harvard's Fogg Museum.

X-ray photograph of same portrait, revealing original condition before it was restored.

A FURORE was created in American and European art circles a few weeks ago by a unique lawsuit brought in the courts of New York by Mrs. Andrée Hahn, of Kansas City, Mo., against Sir Joseph Duveen, internationally known art dealer and connoisseur. Mrs. Hahn demanded $500,000 in damages because Sir Joseph had branded as a fake her highly prized "old master," a portrait of a young woman entitled "La Belle Ferronière" and attributed to Leonardo da Vinci, the great fifteenth century Florentine artist. Sir Joseph asserted the painting was a copy, and a poor one, of a similar picture in the Louvre, the French National Museum in Paris.

Not only artists and art experts, but the world of science, as well, closely followed the trial. For science was called upon to play the dramatic rôle of detective in tracing the possible fingerprints of the counterfeiter of "old masters." Among the foremost witnesses were noted chemists and X-ray specialists. And though in the end the jury failed to agree and was dismissed, vivid light was shed on the wonderful methods now used by scientific investigators to determine whether a work of art is authentic.

Broadly speaking, there are three such scientific methods. By using a filed-off hypodermic needle to remove a tiny piece of paint, not larger than a pin point, from a disputed canvas and placing this particle of pigment under the microscope, color chemists can determine the age of the picture with almost infallible accuracy. Then, by means of microscopic photographs, the artist's brush stroke, which in many cases is as individual as handwriting, can be recognized. Finally, the X-ray tube is brought into play to reveal the picture's telltale "under layers," which frequently leave little doubt of its authorship.

The first chemist to study and distinguish the paints used in different periods was Prof. A. O. Laurie, of Edinburgh, Scotland. He found, for example, that smalt blue was first used by artists at the close of the sixteenth century and that azurite became popular about 1480, to disappear again from the masters' palettes around the year 1650.

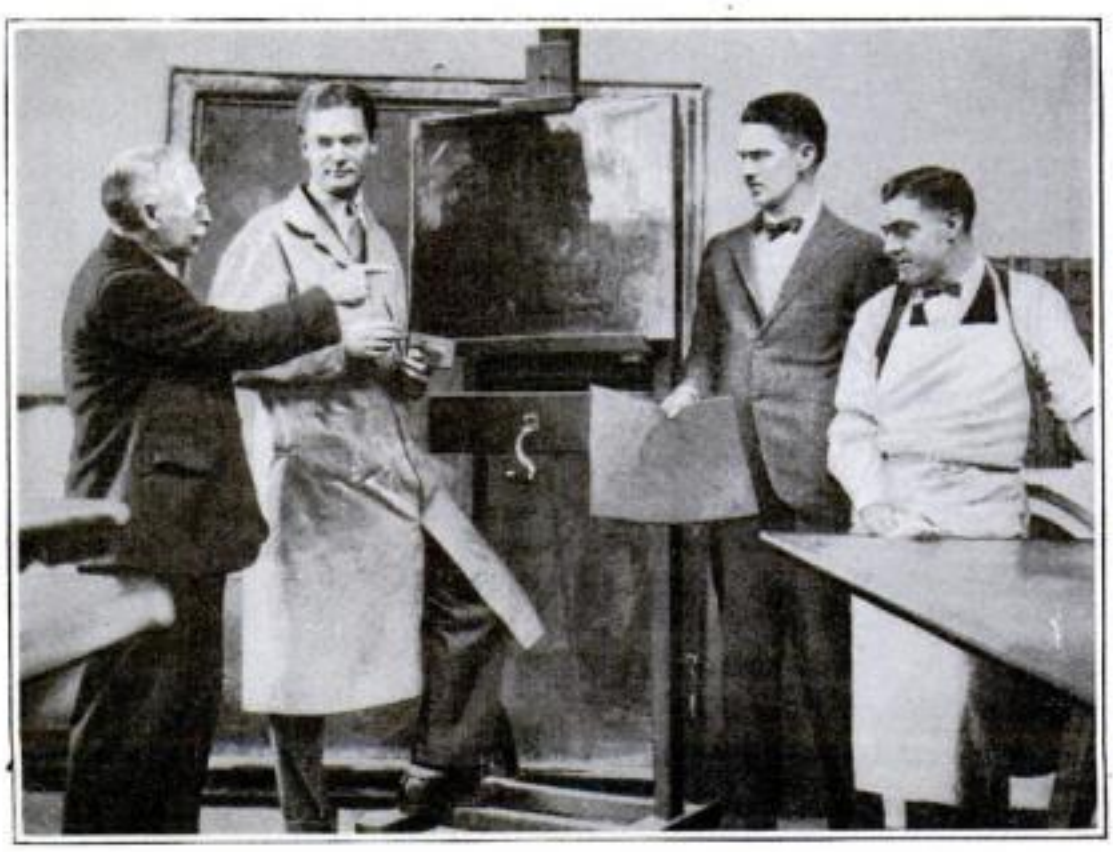
Not long ago, he was asked to pass upon the authenticity of the Rokeby Venus by Velasquez, the great Spanish portrait painter of the first half of the seventeenth century. Professor Laurie entirely disregarded the matter of style and technique. Instead, he examined a microscopic fragment of the paint in a blue ribbon on a cupid appearing in the composition, and discovered that it was a mixture of smalt blue and azurite. In this way, he refuted the contentions of a number of art experts who had declared the cupid to be an eighteenth century addition to the painting.

Incidentally, in the "Belle Ferronière" controversy, Professor Laurie is ranged on the side of the experts who hold that the painting in the Louvre is the genuine one. He recently subjected some of its paints to microscopic examination and found that they were the pigments for which Da Vinci, in his writings, expressed a preference in depicting flesh.

A FEW months ago, six tiny samples, not bigger than a pinhead each, were taken from a painting in California and shipped to Professor Laurie in Edinburgh by the owner, who had some misgivings about its authenticity. Although he had never seen the painting, the chemist was able to reassure the collector!

The other day, Laurie's methods were successfully applied in New York to unmask a canvas that had been offered to a wealthy business man as the work of Jacob van Ruysdael, most celebrated of the seventeenth century Dutch landscape painters. A chemist simply "lifted" three bits of paint and a tiny sliver of the oak panel on which the landscape was painted. The brief report submitted by the investigator is a modern detective story in miniature:

"This painting is an imitation, but is probably between fifty and



Where science trails the art fakers. Testing a painting in the Fogg Museum. Alan Burroughs, expert in the use of X-rays to detect frauds, stands second from the right.

seventy-five years old for the following reasons:

"The white pigment used in the sky is of zinc oxide, which was unknown three hundred years ago. The Flemish painters used flake white and not zinc white.

"The bitumen used in the shadows is still transparent. Bitumen three hundred years old is converted by light into carbon and becomes insoluble.

"A microscopic examination of the wood on which the picture is painted shows that the protoplasm in the cells has not entirely dried out. Wood three hundred years old shows no such protoplasm."

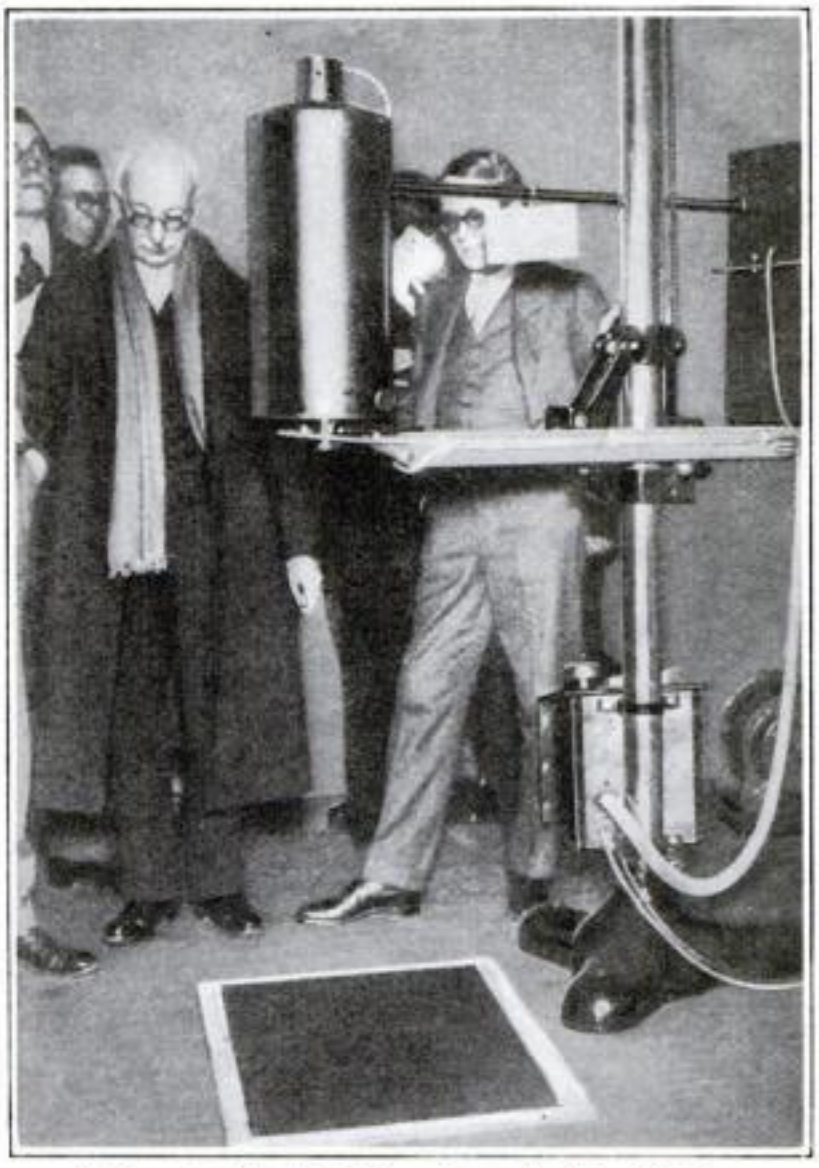
NEEDLESS to say, the fraudulent "Ruysdael" was not purchased.

Speaking of zinc white, Professor Laurie definitely established that it was not used by painters until 1781. The artists of the Florentine school, of which Da Vinci is the foremost exponent, had comparatively few colors to work with. For whites they used either chalk-gypsum or white lead. Their yellows consisted of orpiment, a yellow sulphide of arsenic which blackens in time; Naples yellow, of which lead and antimony oxides are the component parts; and yellow ochre, a clay stained with iron oxides. Their greens were verdigris, a copper acetate; malachite, a copper-bearing ore; and terre-verte, which is a green ochre. The crushed and powdered semi-precious stone, lapis lazuli, furnished them with a blue not unlike the ultramarine of the present day. Their reds were vermilion, a sulphide of mercury; red ochres; red lead compounds; madder lakes, produced from the root of the madder, a flowering herb; and possibly also a red lake derived from a red gum.

On the other hand, our brilliant yellows, such as cadmium and chrome, were not known. It was not until centuries later that cobalt and cerulean blue were first introduced, and Prussian blue was not discovered until 1720. Carmine, which is obtained from a little Mexican insect called the cochineal, was unknown. Thus it is comparatively easy for a color chemist to determine that a picture in which any of these modern pigments are used could not possibly be an example of the Florentine school.

The photomicrographic method of detecting frauds also was developed by Professor Laurie, who makes photographic enlargements of two to five diameters. Some years ago, the authenticity of Rembrandt's famous "Good Samaritan" was questioned. Professor Laurie confounded the cynics by making enlargements of the brushwork in this picture, which is one of the star exhibits in the Wallace collection in London, and likewise of Rembrandt's "Woman Taken in Adultery" in the National Gallery, and pasting parts of the print of one over that of the other. The experts were entirely unable to tell the difference!

The X-ray system of picture examination now is used in virtually all of the large art galleries in Europe and America.



S. Kennedy North, British artist and critic, with X-ray apparatus for testing paintings and exposing forgeries.

Some years ago, Dr. Alexander Faber, of Weimar, Germany, discovered that X-rays could be employed to determine whether an old master was an original, a restoration, or a falsification. He found that X-rays penetrate some pigments more easily than others. A heavy pigment appears beneath a light one, just as, in the case of medical application of X-ray photography, a bone appears distinctly beneath a covering of flesh.

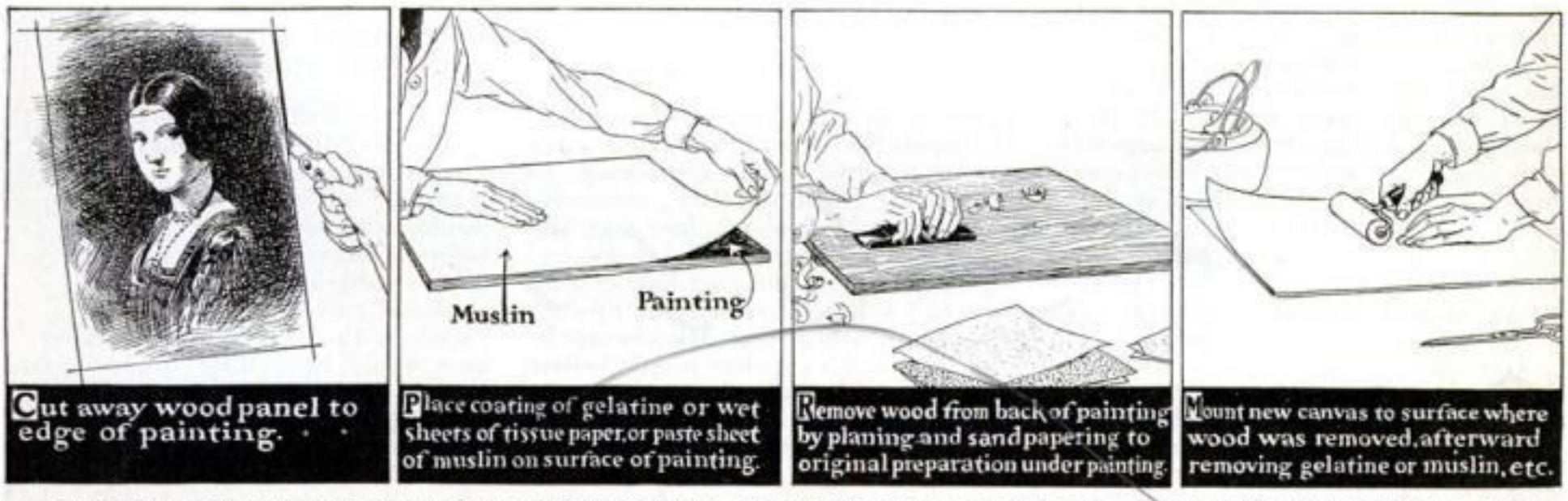
Dr. Faber's work was developed in Europe by Dr. André Cheron, of Paris, and Dr. Heilbron, of Amsterdam, and in this country by Alan Burroughs, who, for the last eighteen months, has been making extensive X-ray experiments in the Fogg Art Museum, at Cambridge, Mass. This museum now has a file of about 1,000 X-ray photographs of masterpieces, representing the peculiar characteristics of many masters, ancient and modern.

Through application of the X-ray method, Burroughs not long ago established the authenticity of a portrait by Frans Pourbus, noted sixteenth century Flemish artist. The picture was supposed to be a likeness of Queen Elizabeth, but the features were so insipid and ultra-feminine that some American critics doubted the identity of both the artist and the sitter. Other experts, however, believed that the painting bore the unmistakable marks of Pourbus' technique.

BURROUGHS, with his X-ray apparatus, found an "under layer," revealing the same general characteristics of the painter's handiwork but showing a lady of much stronger features. In fact, the "invisible" picture underneath the visible one conformed to the generally accepted idea of Queen Bess' somewhat mannish appearance. The inference finally drawn was that Pourbus had been prevailed upon to "doll up" his original portrait.

An idea of the importance of modern scientific detection was given not long ago by Dr. Wilhelm Bode, of the Kaiser Wilhelm Museum in Berlin.

"Rembrandt," he said, "painted about 700 pictures. Of these, more than 3,000 are in existence!"



How restorers create "canvases" out of old paintings which were originally done on bases of plaster or similar material mounted on wood. After the painting has been cut from the panel, its face is covered, Then the wooden back is carefully planed away and a canvas mounted in its place.

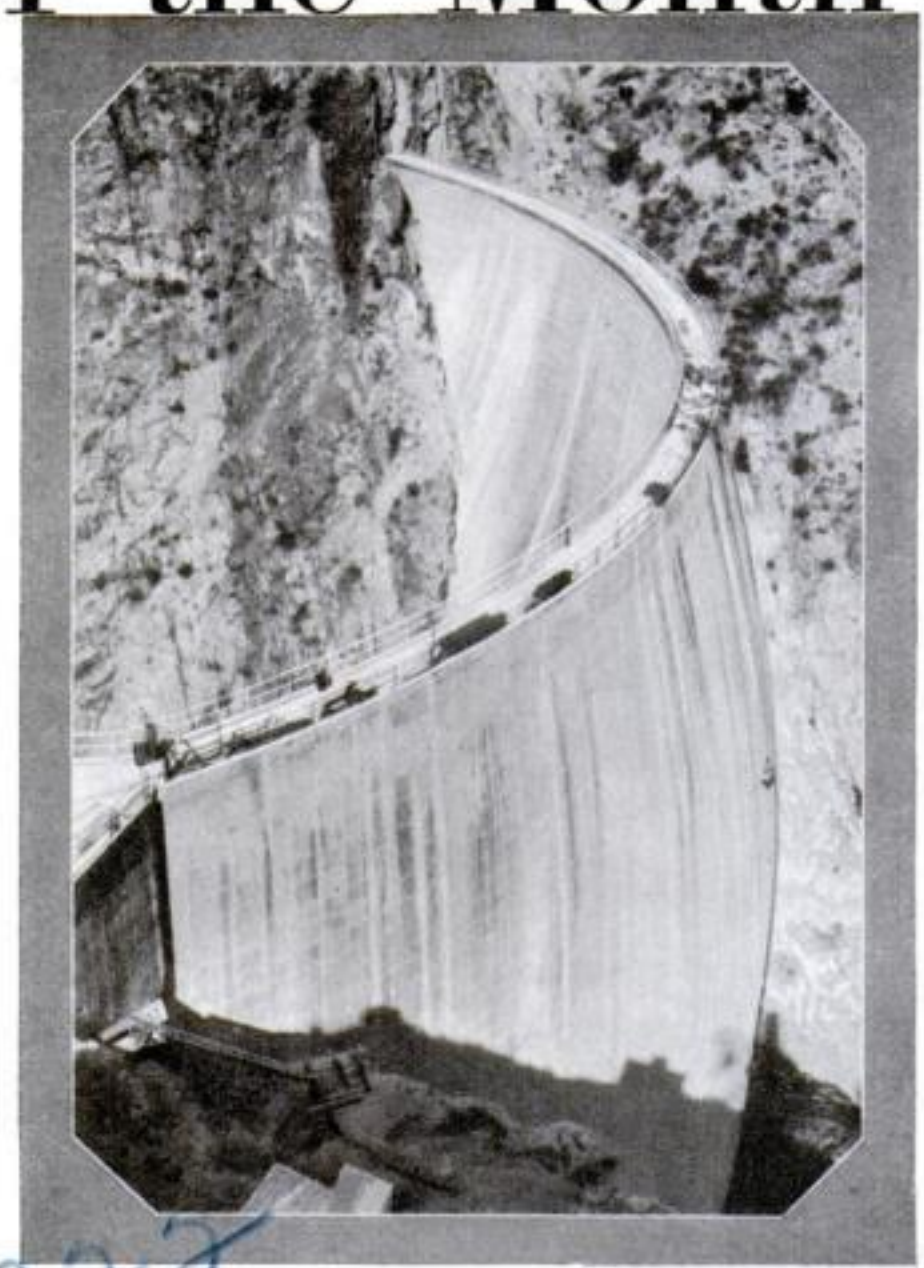
Back of the Month's News

By
KARL VOOGHT

IN SOUTHERN California, the highest dam in the world has just been completed. It stands in the Pacoima Canyon, an arched wall of reinforced concrete nearly two and a half times as high as Niagara Falls! This cement barrier, 385 feet from base to top, will guard the fertile San Fernando Valley from floods.

The new dam's hold upon the record for height will be short lived, for the Owyhee River Dam, in Oregon, already under construction, is to be 405 feet high, or twenty feet taller than the Pacoima structure. The possible height of reinforced concrete dams seems to be limited only by the solidity of their rock foundation.

Ever since man began to settle down and build solid dwellings, some sort of cement has been used. Mud probably was the first cement. The Great Pyramids of Egypt were held together by a mortar of burned gypsum. Volcanic ashes and burned lime made the strong masonry of Rome possible. Since 1870, the United States has been using Portland cement, but only since 1910 has reinforced concrete come into wide use. Today, it is surpassed only by steel as a building material and its possibilities in bridge and dam construction are just beginning to be realized.



A giant concrete barrier—Pacoima Canyon Dam, highest in the world. It will guard San Fernando Valley, Calif., from floods. Right: Looking up the face of the lofty wall, which is nearly two and a half times as high as Niagara Falls.

Your Newspaper by Radio

A NEW YORK corporation has applied to the Federal Radio Commission for permission to establish radio newspapers in the cities of New York, Washington, Boston, Chicago, Cleveland, Columbus, Cincinnati, Detroit, Kansas City, St. Louis, New Orleans, Atlanta, Salt Lake City, San Francisco, Los Angeles, Seattle, Minneapolis, Dallas, and Philadelphia. The company has for its purpose distribution of news only.

It is a far cry from this proposal to the town criers who provided Americans of the Revolutionary period with their daily news. The nineteenth century was well under way before daily newspapers began to attract large circles of readers. And the first quarter of the twentieth century has brought daily newspapers to their highest development, the total net circulation of American newspapers now being more than 37,000,000 daily.

Thoughtful newspaper men, watching America's radio audience grow to more than 40,000,000, for some time have been summing up the possibilities of radio supplanting big dailies as a distributor of news. Broadcasting stations all over the land have been sending out news bulletins and Americans in general are beginning to get their first word of great and important events direct over the radio.

If the Federal Radio Commission grants the petition filed by the National Radio Press Association, methods of dissemination of news may be radically altered. However, while radio may change the character of newspapers, it is not believed it will entirely supplant printed news.

Men and Microbes

FOR the first time in history, plants and animals have been raised in surroundings one hundred percent germ-proof. In the Pasteur Institute, Paris, successive generations of tadpoles, guinea pigs, and miscellaneous varieties of insects and herbs grow up without ever having come in contact with a microbe—and thrive.

The result is surprising. Microbes are far from as harmful as some people believe them. Some, of course, are responsible for tuberculosis, cholera, and typhoid fever; but others help the baker make bread and the farmer to grow peas and clover. If it were not for such microörganisms as these that cause fermentation, and that live on the roots of plants and feed them, mankind as a whole would probably perish. Whether a human being could gain by isolation from the swarm of billions of microbes, good and bad, that surround him every minute is another question.

Curious are the works of some of these tiny single-celled creatures. Just one little microbe, "azo bacter" by name, in a sense built the Panama Canal. Chile saltpeter, from which by an indirect process the nitroglycerin used to blast the canal was obtained, is formed by the action of this microbe upon organic matter. Another microbe lives in the mud of swamps and manufactures marsh gas. It is this germ that Prof. J. B. S. Haldane, British biologist, suspected of concealing itself in the moist, dirty subsoil of London and generating the mysterious gas that not long ago blew up a mile of streets. Pasteur himself, the great biologist, doubted that a man could live if he were wholly isolated from germs. But other workers have held that man might prolong his span of years by excluding at least injurious bacteria. The Russian bacteriologist Metchnikoff traced the decrepitude of old age to chronic poisoning caused by microbes.

Urge 24-Hour Clocks

THE International Astronomical Union recently adopted midnight as the starting point on the clock instead of noon, giving the dial twenty-four instead of twelve hours and abolishing the symbols "A.M." and "P.M." At the same time, all transportation companies in Great Britain were urged to conform to this system.

The principal objections against the proposed system in England are that it would make time-tables more involved than they already are, and that much mental arithmetic would have to be done before telling time by the new clock would be an established habit.

Should such a change ever be introduced in the United States, ex-service men would have little trouble getting used to the new system. As all former overseas men remember, the twenty-four-hour method of telling time is in use on the railroads of France, Belgium, Germany, Switzerland, and Austria. Aside from the railroads, however, the twelve-

hour clock is used in all of these countries, as in England and America.

In England, proponents of the new clock say it will be easy for travelers to adjust themselves to realizing that 17:15, for example, simply means a quarter past five in the afternoon, that thirteen o'clock is one P.M., and 21:55 stands for five minutes to ten at night. They contend, too, that the change will facilitate trans-Channel traveling, especially since the British railroads are planning route connections with cross-Channel flying services, which have to go by the twenty-four hour system on the European continent and shift back to the old clock when reentering British air.

Our present one to twelve clock system once was considered a great advance. The Romans, as early as 158 B.C., had a clock run by water that told the hours during the night, but a really competent clock was not developed until the second half of the eighth century. Later, King Alfred of England devised a method of telling time by candles, the burning of three inches denoting the passing of one hour. Our present twelve-hour clock was invented by monks in the Canterbury Cathedral, England, at the close of the thirteenth century.

Where Our Energy Goes

WHEN Dr. Carl Tigerstedt of the University of Helsingfors, Finland, made tests recently of the energy consumed in dancing, he found that in the waltz a person of normal weight expends enough bodily heat to raise the temperature of five pints of water from freezing to boiling. The Charleston consumes more energy than sawing wood. The mazurka stands next to wrestling in strenuousness.

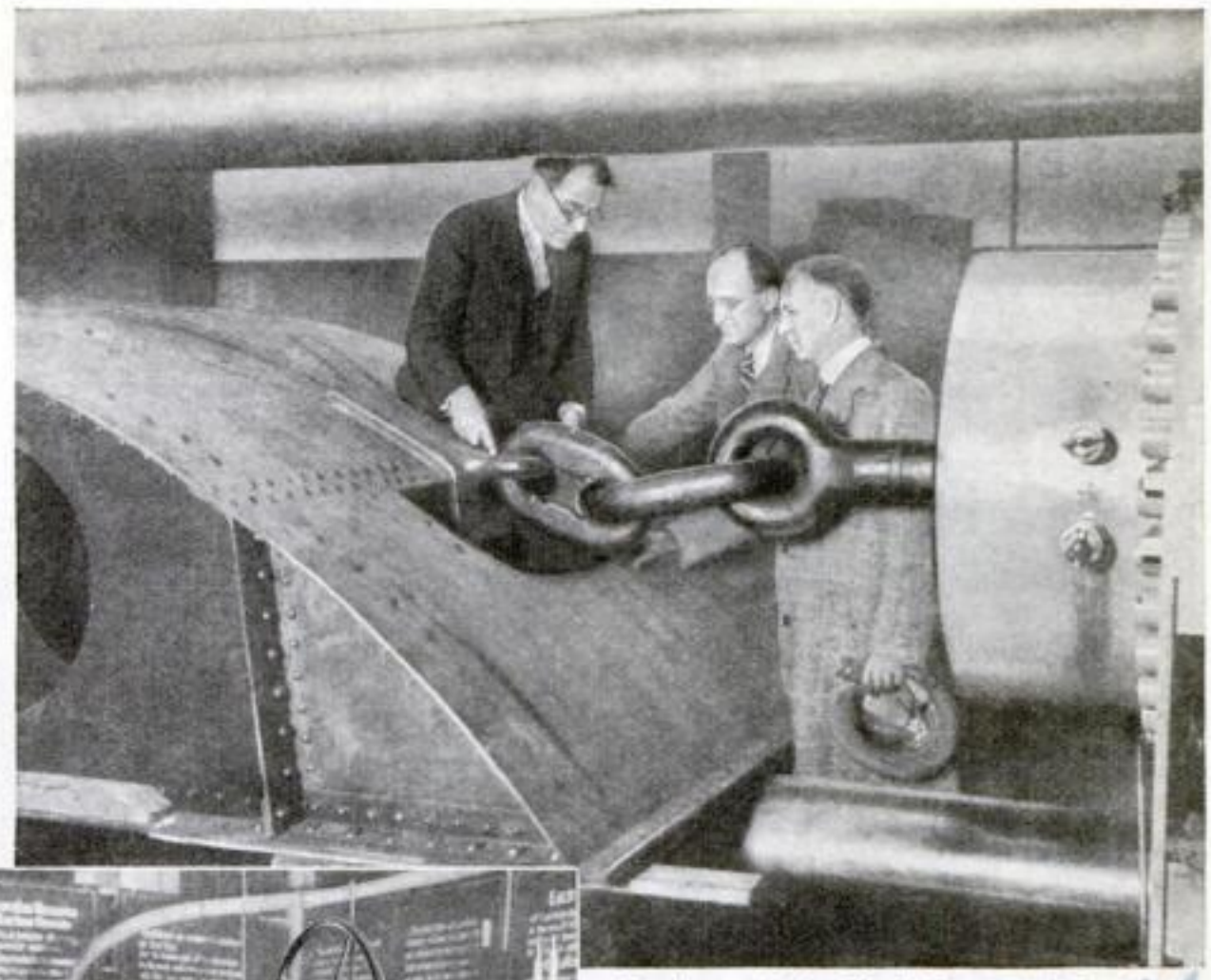
Our bodies are internal combustion engines, speeding up and slowing down, but never stopping. Even when we sit still, the engine keeps running, but it is "out of gear," consuming less fuel with decreased wear and tear. By lying quiet, you can save your heart 20,000 beats a day.

Some interesting facts about the fuel consumption of this human engine have been discovered. The older we become, the less we burn. Men burn more in proportion to their weight than women. If two people are sitting, the taller and heavier one will consume more fuel.

Where our energy goes during the day has been fairly accurately determined. By collecting in rubber bags the breath expelled by workers in performing different tasks, scientists have been able to measure how much energy each kind of work takes. The amount of carbon dioxide given off by the lungs is a precise gage of the amount of fuel consumed.

Such tests show that a housemaid consumes more energy than a carpenter or a house painter. Dressing a baby requires seven times as much energy as sewing by hand. Washing takes more energy than any other task around the house, with sweeping next. Ironing is about half as hard as washing.

When a woman has to lean over a table that is too low, she uses up a quarter again as much energy as when the table is of proper height. A farmer's wife who put a pedometer on her ankle found that she averaged from twelve to eighteen miles a day in walking about the house to do her work. Such waste of energy is being conserved in millions of homes by better arrangement of the kitchen and by the adoption of labor-saving equipment.



Engineers of the U. S. Bureau of Standards inspecting a submarine "pad-eye" rescue ring tested by the huge pulling machine at the right.

Measuring energy expended by a typist at work in an air-tight chamber, by the quantity of exhaled carbon dioxide gas in air pumped from chamber.

How Much Do You Know About Electricity?

TEST your knowledge with these questions, chosen from hundreds asked by our readers. You will find a list of the correct answers on page 166.

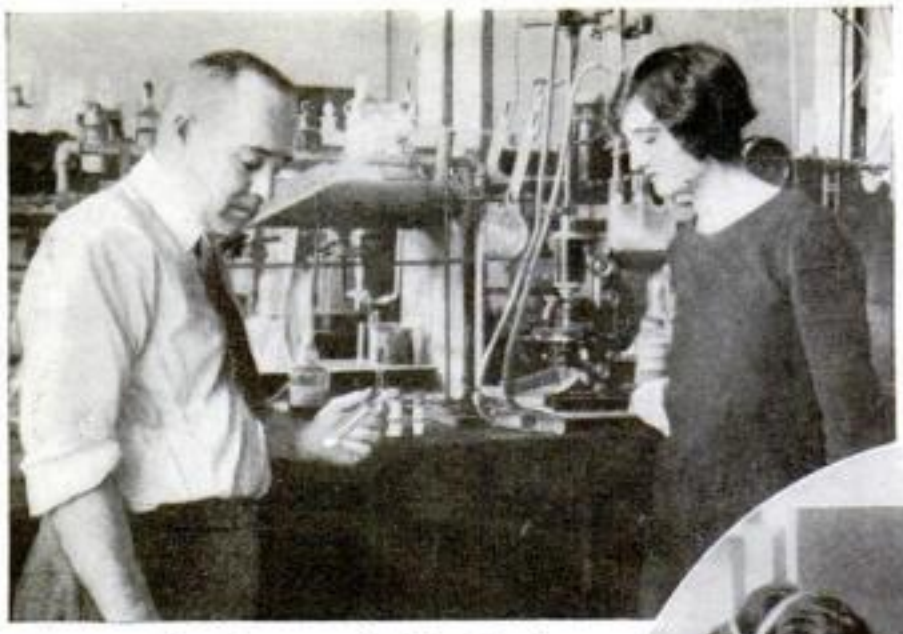
1. **What is "static" electricity and what makes it different from electricity that flows in light wires?**
2. **How much electricity does it take to kill you?**
3. **If air is a nonconductor of electricity, how does a spark jump through it?**
4. **What makes electric light bulbs pop when smashed?**
5. **Is there electricity in the air all the time?**
6. **Does insulation keep electricity from running off the wire?**
7. **What is the difference between positive and negative electricity?**
8. **What substance is the best conductor of electricity?**

Making Submarines Safer

"PAD-EYES," the steel rescue rings attached to the hulls of submarines so chains can be hooked on for lifting disabled undersea craft to the surface in case of accident, recently passed strenuous tests conducted by the U. S. Bureau of Standards in Washington, D. C. A mighty hydraulic machine, with a maximum pull of two million pounds, was attached to one of the rings. As the machine began to pull, a recording dial first showed 40,000 pounds. Quickly it rose to 180,000 pounds. Then the needle advanced more slowly. When it pointed to 480,000 pounds, the plates inside the model submarine hull, to which the pad-eye was fastened, began to buckle. At 530,000 pounds, the eye snapped, but the hull model remained intact.

Engineers said that this resistance to 265 tons pull—more than twice that of the world's largest locomotive—will make the rings equal to any sudden jerk of pontoons during the process of lifting a sunken submarine. The pad-eye is one of the inventions which followed the sinking of the *S-4* off Cape Cod in December, 1927.

Another plan for raising sunken submarines passed a successful test by the U. S. Navy off the coast of Porto Rico recently. The *S-29*, with special valves built into the hull, was sunk in fifty feet of water. Divers, bringing air hose from a salvage vessel above, attached them to the valves. Air pumps then blew the water from the ballast tanks and brought the submarine to the surface. During the



Dr. R. F. Jackson and Dr. Sylvia Goergen, of the U. S. Bureau of Standards, with a tube of inulin, a starchlike substance from dahlia plants, from which they obtained new sugars.

Edward H. Hansen, Los Angeles electrical engineer, with his invention called the osciographoscope which, he says, makes possible motion pictures of the human heart in action.

process, other hose carried fresh air to the "imprisoned" crew.

Future submarines may be able to travel thousands of miles without coming to the top. Meanwhile, inventors are bending their efforts toward increasing safety of under-water travel.

How Insects See Us

RECENT experiments at Columbia University show that the eyesight of bees has been overestimated. Dr. Ernst Wolf and Prof. Selig Hecht discovered after a series of experiments that the bee has only about one percent of the perception of a human being.

A human eye has only one lens; those of insects many. A fly, for example, has from 5,000 to 6,000; a dragon fly more than 20,000. Working under a powerful microscope, Dr. Alfred M. Clough, a British biologist, cut a tiny strip, containing forty or fifty lenses, from a house fly's eye. By means of a specially constructed camera, he photographed objects through the strip. The pictures showed that each lens gives a clear and separate image. Flies, however, he discovered, do not see a thousand swatters when only one is raised. The images reach the brain as one.

A similar experiment showed how an Oxford professor looks to a humble glowworm. Another British biologist, Dr. H. Eltringham, made a photograph through a glowworm's eye, one fifty-thousandth of a square millimeter in size—far smaller than the period at the end of this sentence. The prepared eye was mounted on a minute drop of diluted glycerin and the photograph taken through it. It showed that the insect has surprisingly clear sight. Enlarged 500 times, the photograph was easily recognized as that of the Oxford professor by all who knew him.

Sugar from Flowers and Medicine from Sugar

IN THE bottom of a test tube in the laboratory of the U. S. Bureau of Standards, Washington, D. C., experimenters recently examined a bit of starchlike substance extracted from dahlias. What they found may result in thousands of acres being planted with these flowering plants and our sugar bowls being filled with a new kind of sugar.

The starchlike substance was inulin. An acid treatment changes it into fructose, a very sweet sugar which is more easily assimilated by the human system than cane sugar. While extracting the fructose from dahlias, Dr. R. F. Jackson and Dr. Sylvia Goergen, of the Bureau laboratories, unexpectedly found a second sugar, called difructose anhydride. It is believed to be composed of two molecules of fructose combined in such close union that acid is unable to convert it into fructose. Other tests have shown that peanut shells and sunflowers are possible sources of sugar.

More than fifty sugars, some bitter to the taste, are now known to science. Each is essential to the life of some plant or animal. A few of them have been thoroughly studied. Others are still a mystery. In the Public Health Service laboratory in Washington, two noted chemists, Dr. Claude S. Hudson and Dr. Eugen Pacsu, of Budapest, Hungary, are studying these sugars in search of new medicines. They believe nutritive disturbances may possibly be cured by their use.

Since the Crusades, when sugar first became known in Europe, it has had an ever-increasing demand. In the early fourteenth century in England two pounds cost as much as a pig, or as much as a carpenter could earn in ten days. It was in search of sugar and spice that Columbus came to America, seeking a short route to the "sugar bowl" of the Orient.

Beet sugar, now supplying half the world's need, began to be cultivated seriously slightly over a century ago. Napoleon encouraged its production when the allies were blockading the ports of continental Europe.

Now, it seems likely that sugar from flowers as well as from beets and sugar cane may be placed on a commercial basis within a few years.

How an Oxford professor looks to a glowworm. This remarkable photograph was taken through the eye of the insect in place of a camera lens, by Dr. H. Eltringham, British biologist.

Heartbeats in Movies

AN ELECTRICAL engineer, Edward H. Hansen, of Los Angeles, Calif., reports he has perfected an invention by which a motion picture camera can take photographs of a heart pulsating within a living person. He calls his machine an osciographoscope and says it will bring about a new system of diagnosis for heart ailments.

The stethoscope records only the sound of the heart in action. The x-ray allows it to be seen, but it does not give any permanent record for study. The new device, says the inventor, will record the slightest pulsation or change in the heart, so that the pictures, thrown on the screen, can be examined and studied by several physicians.

Considered as a piece of machinery, the human heart is about the most efficient part of the body. It works continuously for half a century and more, sometimes for a hundred years, without stopping to be overhauled for repairs. It is composed of muscles which are extremely tough. They expand and contract with rhythmic regularity at an average rate of seventy pulsations a minute. The average life of an American is now above fifty-five years. In that period his heart will have pulsated two billion, one hundred and forty-four million, two hundred and thirty thousand times!

It is only 300 years since William Harvey published his discovery of the circulation of the blood, in 1628. In those three centuries we have learned about the mechanism of the heart. We know that its operation is that of a pump. Each expansion draws into the left ventricle, one of the four chambers of the heart, about four tablespoonfuls of blood which has completed its seven-minute circuit of the body and has been supplied with fresh oxygen by the lungs. The blood passes through the four chambers, being forced out into the arteries through the tricuspid valve at the top of the right auricle.

And that is about all we really *know* about the heart. There is still much to learn about why and how infectious and nervous diseases affect its muscles and its valves, throw it out of rhythm, and tend to shorten its usefulness.

The most valuable feature of the heart is its elasticity. It will stand immense strain and recover without stopping its work. But just what any given individual ought to do to keep his heart in perfect condition under the circumstances in which he has to live is something which

each has to learn for himself. Some hearts are easily affected by nervous strain, tobacco, alcohol, coffee, or even by eggs; others seem to be immune to those things but susceptible to others.

As a rule, the smaller the heart in proportion to the body, the more efficient it is; an enlarged heart usually means softened muscles. Nurmi, the Finnish runner, owes his great endurance, physicians say, to the fact that his heart is only about half the normal size and beats only fifty times a minute. A slow-beating heart generally lasts longer than one which pulsates rapidly; and in general, the muscular condition or "tone" of the whole body is reflected in the heart's structure. Soft muscles mean a soft heart, which is why violent exercise often causes the death of those unused to exertion.

100-Story Skyscrapers?

RECENTLY it was announced that a Chicago man, Edward C. Kerth, had invented a new light building tile, bringing visions of skyscrapers twice as high as the Woolworth Building.

Most of the present materials for which the tile might be substituted weigh 120 pounds a cubic foot. The new product is said to weigh less than twenty pounds a cubic foot. As weight is an important consideration in limiting the height of skyscrapers, Professor George A. Bole, of Ohio State University, prophesies that use of the new material will allow 100-story buildings in the future. The Woolworth Building, in New York City, has sixty stories.

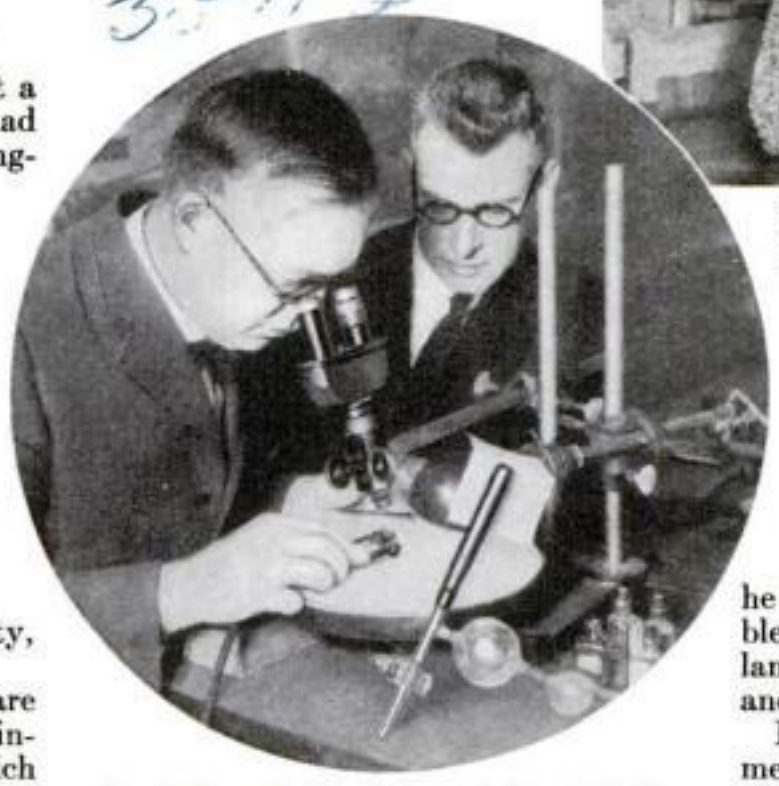
The process by which the tiles are made is being kept a secret by the inventor. The "mystery clay," of which they are composed, is made into worm-like strings and compressed into bricks. At first glance, these bricks look like blocks of spaghetti. In the compressed form, the tiles weigh fifty pounds a cubic foot. By a second process, called a "yeast treatment," chemicals are used to inflate the blocks, reducing their weight to between eighteen and twenty pounds a cubic foot. This is accomplished without materially reducing their strength, it is reported. If thrown into water, the tiles would float like corks. Their density is less than that of bamboo.

Besides being of light weight, the inventor says the tile is weatherproof, and will not deteriorate with age. If the expectations for the new tile are realized, the Kerth invention may be the most important in centures of tile-making, which dates back to the early civilizations of Assyria and China. It may even lead the way to man-built mountains—skyscrapers a mile high in which workers, breathing the pure upper air, will look down upon cloud banks from their office windows!

Taking the Moon's Temperature

TWO astronomers at Mt. Wilson Observatory, Dr. Seth B. Nicholson and Dr. Edison Pettit, by means of a minute thermocouple, have taken the temperature of the moon before and after an eclipse. If you placed a single drop of water in one pan of a balance scale, you would have to place a thousand of their tiny instruments in the other pan to strike an even balance!

As a result of their experiment, Dr. Paul Epstein, of the California Institute of Technology, has determined that the frozen surface of the moon was once covered with fiery volcanoes. Experimenting with various materials in his laboratory, he found that pumice, of volcanic origin, cooled at approximately the same rate as the moon when placed under laboratory conditions similar to those on the moon when it is in the shadow of the earth during an eclipse. From this he deduced that the features of "the Man in the Moon" which we see are mountains of volcanic origin.



Dr. Edison Pettit (left) and Dr. Seth B. Nicholson, astronomers of Mt. Wilson Observatory, examining the tiny thermocouple with which they measured the moon's temperature.

Edward C. Kerth with samples of his light new building tile, showing how it looks before and after inflation by a novel "yeast treatment."

Each part of the globe has its legends about this imaginary man. In China, for instance, he is supposed to govern marriages, tying together young men and maidens with an invisible silken cord. In New Zealand, he is supposed to be a native who stumbled at night and sprained his ankle, and lamented so loudly the moon came down and sailed back into the sky with him.

For such legends the delicate instruments of astronomy are substituting fascinating new facts about the moon and its features.

Sifting a City's Smoke

DR. H. H. SHELDON, New York University physicist, is mapping the spectrum of sunlight in different parts of New York City to determine the amount of ultra-violet rays that come through the smoke and dust in the air. City dwellers, feeling their backs warmed by the sunshine, imagine they are getting the full benefit of sunlight. Tests prove, though, that the infra-red, or heat rays, rather than the ultra-violet, or health rays, are the ones that most readily break through dusty air.

At ten o'clock in the morning on a certain day not long ago, a cubic inch of air over London, England, was found to contain 340,000 particles of soot! So fine are such particles that about ten thousand of them are required to form a speck weighing one milligram, or one-four-hundred-and-fifty-thousandth of a pound! Yet, Dr. J. S. Owen, of the British Meteorological Office, estimates that the number of soot particles which Londoners breathe in one hour would, if put end on end, circle the globe 2,500 times!

Winds carry smoke and dust from factory districts hundreds of miles. After volcanic eruptions, dust particles often travel around the world. An April dust shower that is estimated to have dropped 1,800,000 tons of dust over Europe was traced to high (Continued on page 161)

Dr. H. H. Sheldon (left), New York University physicist, measuring ultra-violet rays of the sun that filter through New York's smoky air.

The Real Fathers *of* Flight

Honored by Kings and Feted by Royalty—Another Absorbing Chapter in the Inside Story of Wilbur and Orville Wright

By JOHN R. McMAHON

Wilbur Wright in his prime. This photograph was taken at about the time he was flying before kings and being sought by nobility.

King Victor Emmanuel of Italy, camera in hand, with Orville and Wilbur at Rome in 1909.

Wilbur messed frequently with Italian officers and claimed he set a record by devouring "forty-seven miles of macaroni."

After Mr. McMahon had completed this article, came word of the death, in Kansas City, Mo., of Mrs. Henry J. Haskell, formerly Katharine Wright, sister of the inventors of the airplane. Throughout their early struggles, it was the loyalty and devoted aid of their beloved "Sterchens," as related in this story, that carried Wilbur and Orville Wright from disappointment to the eventual triumphs in which Katharine shared.—THE EDITOR.

"YOUR Majesty, may I present the Wright brothers of Dayton, Ohio?"

"This is an honor and pleasure!" exclaimed Alfonso of Spain, smiling as he shook hands vigorously with Wilbur and Orville. "What a marvelous invention your airplane is!"

The brothers grinned politely and bowed a trifle.

"I would ask the great privilege of a trip in the air," continued the young monarch, "except for one thing—"

"What is that, Your Majesty?" delicately prompted a courtier.

"My Queen and Cabinet made me promise not to do it!" said Alfonso with a rueful laugh in which the little group of notables on the flying field at Pau, France, discreetly joined. "Yet they say a king can do as he likes."

If a scene like this had been visioned in a tea cup by Sister Katharine half a dozen years earlier, Wilbur and Orville would have said, in effect:

"Not a chance, Sterchens. Maybe we'll get into a circus sideshow, unless we're just embalmed in a scientific encyclopedia."

In fact, the virgin flight of the airplane at Kitty Hawk on December 17, 1903, had buried the inventors under a mass of ribald publicity. Europe learned some of the facts first when Octave Chanute lectured before the Aero Club of France, telling about the remarkable feats of his young friends, the Wrights, and showing pictures of their glider. Thus the French early began to annex the invention. They were frank about it, calling their machines "the Wright type." However, they bungled in the absence of a model and air table figures giving the proper curves for wings and propellers.

The world's first regular flying field was an eighty-acre cow pasture eight miles from Dayton. Here, in 1904–5, the brothers developed the airplane, making hundreds of flights when no other human

The excited Frenchman exclaimed: "The French government buys the Wright plane for one million francs. But—"

The Empress of Germany watching a flight of the Wright machine in 1909. The Kaiserin is seen standing in the back of the royal car. European royalty flocked to see these early flights.

beings flew at all. They learned to steer and to circle, steadily increased their own records of distance and duration. Local reporters were invited to witness the first attempts and these being failures, the writers decided not to waste time on the "airship." They thought it was a dirigible balloon.

THE British war department sent an agent to investigate the new vehicle in the fall of 1904, which prompted the Wrights to offer it first to Uncle Sam. Our war department was not interested. When Wilbur the next year made a record of twenty-four miles in thirty-nine minutes, the French government became interested and sent a scout, followed by a military commission, to Dayton. Meanwhile the brothers again offered the airplane exclusively to our war department and again were rebuffed.

"There is no such animal as the airplane," intimated in effect the military experts at Washington.

The foreign copyists became busy. The first of them to make a seeming success with a near-plane was Santos-Dumont. He devised a T-shaped box kite affair, added a powerful motor, and in November, 1906, made a straightaway hop somewhat shorter than the Wrights' epochal first flight three years earlier.

In early 1907 the Aero Club of America, with numerous millionaires in its membership, opened a subscription to pay Wilbur and Orville $100,000 for their patent rights in the United States, which would then be turned over to the Government or released to our home public. In six months a total sum of $11,000 had been raised. Men were still skeptical.

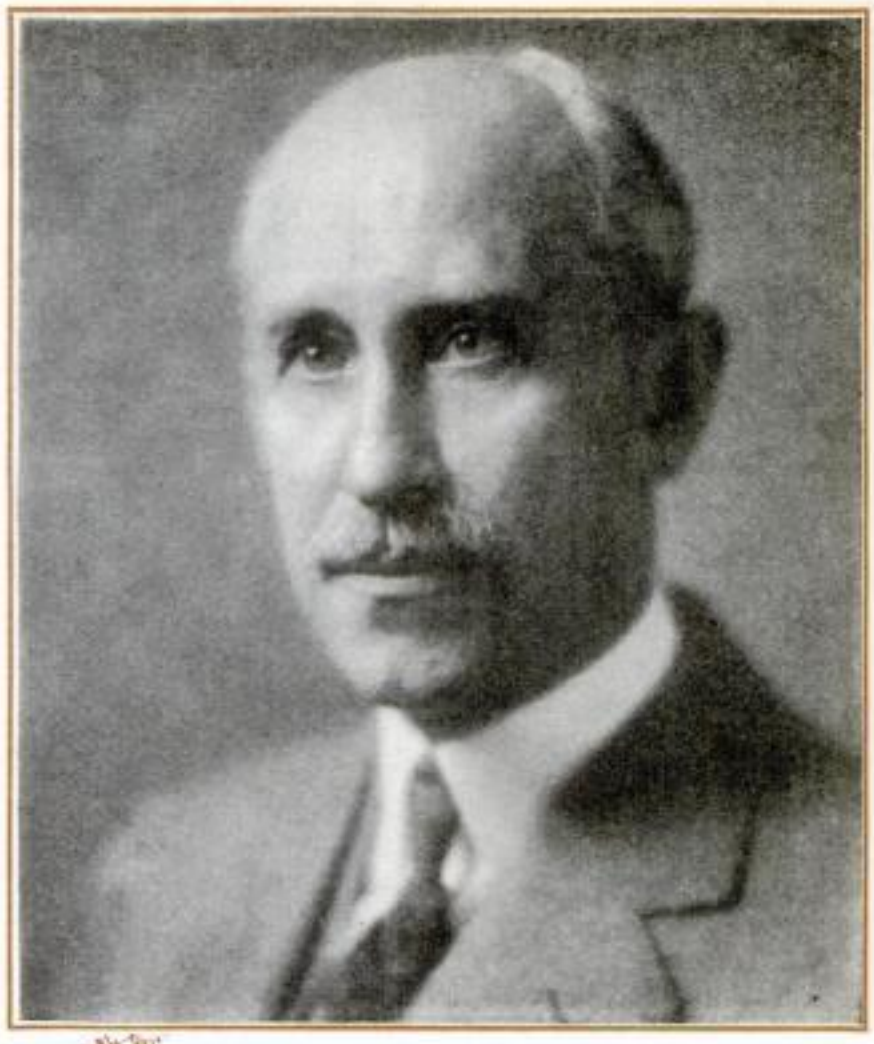
Our war department, prodded by President Roosevelt, now wrote to the inventors, asking:

"What price airplane?"

"To Uncle Sam—now—$100,000," replied the brothers in effect. The officials said they regretted they did not have that much money to spend, whereupon the Wrights agreed to supply a plane on feasible terms.

Around this time the machine seemed to be sprouting golden wings. A French syndicate headed by M. Deutsch, oil magnate and balloon patron, came within an ace of buying the European rights in the invention for $750,000. Intrigue spoiled the arrangement, but a new deal was launched for the sale of the airplane to the French government. The brothers were together in Paris in midsummer of 1907 to consummate the transaction. The price was fixed at one million francs.

Jimmy Hare, veteran war photographer, was so amazed when the unearthly bird roared past him that he forgot to click the camera shutter!



Orville Wright as he looks today. A recent photograph, taken 25 years after the first airplane flight.

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The brothers explaining their machine to King Edward VII of England at Pau, France. Wilbur is in foreground, Orville at left. The King (wearing derby) seemed to have little interest.

A British war department agent paid a visit. This prompted the Wrights to offer the machine to Uncle Sam.

At last the budget committee of the war department met to act. The expectant Wrights awaited the decision in their hotel room. The door was flung open. An excited man slammed the door, hesitated, then exclaimed:

"It is all right! Everything is going through. The French government buys the Wright machine for one million francs. But—there is one little thing to be done. . . ."

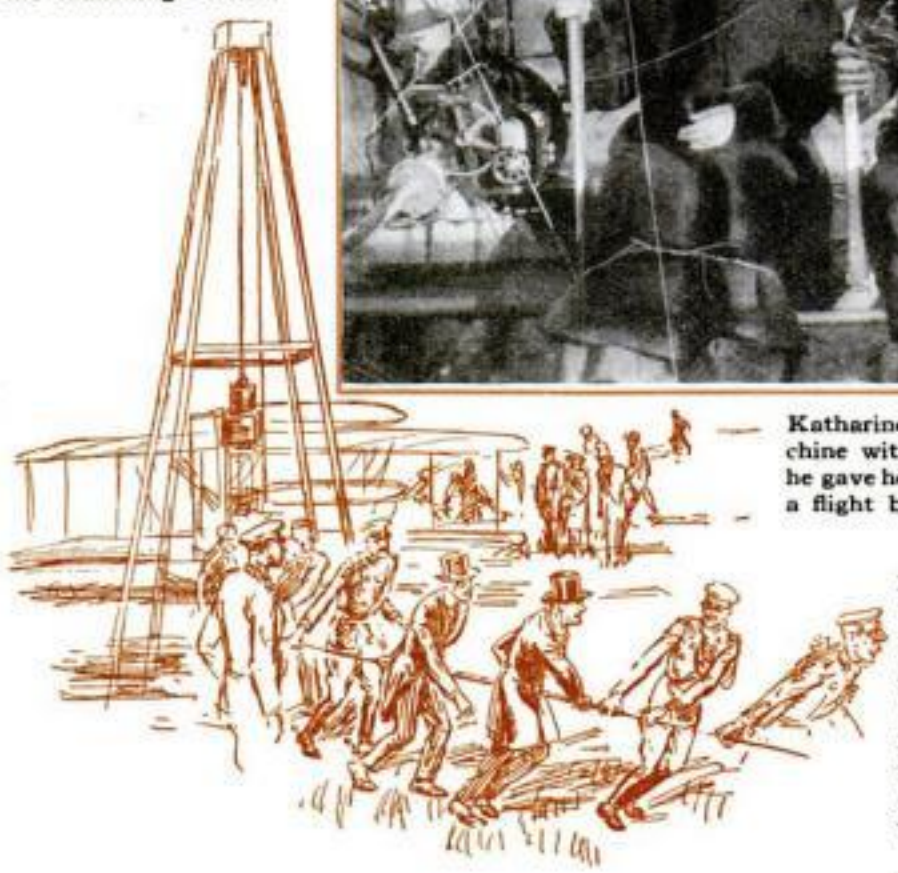
The brothers calmly waited for the embarrassed spokesman to continue:

"YOU will get your million francs, all right. No trouble about that. It is just that it is necessary to make a change in the wording of the contract, so that you ask one million two hundred and fifty thousand francs. Then it will go through this afternoon. And you will get your million francs."

Wilbur and Orville kept looking at the speaker. They acted as if they were deaf or did not quite understand. They were in dire need of money. So far, four years after their invention, it had yielded them no profit. Indeed, it had swallowed their savings and lately had put them in debt to their sister Katharine, who had mortgaged the Hawthorn Street home, then owned by her, in order to aid them. A million francs—$200,000—would wipe out the mortgage and every other care, and give independence for a lifetime of absorbing exploration in fields of knowledge yet unknown.

"Orville and I have no objection"—Wilbur spoke in quiet staccato—"to the terms. That is, with the understanding that the contract names the man who gets the additional two hundred

The high and mighty of Europe vied for the honor of pulling the rope which hoisted the heavy weight of the launching derrick.



Katharine Wright seated in the machine with her brother Wilbur after he gave her a surprise by taking her for a flight before the King of England.

and fifty thousand francs and states his position on the budget committee."

And so the provincial Yankees lost their million francs!

Meanwhile copyists were busy with near-planes. Delagrange hopped. Henry Farman, adding ailerons to a Voison machine, made a straightaway flight of half a mile in October, 1907.

Wilbur was on his way to St. Petersburg in August, thinking optimistically that rubles might contain less alloy than francs, when he found another opening at Berlin, and was joined there by Orville. German officials agreed that if the brothers actually flew a machine in their presence, the Imperial German government would do business.

THE inventors returned to America in the late fall and took up with our war department the building of a plane for Uncle Sam. A contract was awarded to the Wrights at their figure, $25,000.

The Aerial Experiment Association, headed by Alexander Graham Bell, began work. Its director of experiments was Glenn H. Curtiss, motorcycle rider and engine builder. Its secretary was Lieut. T. Selfridge, who wrote to the Wrights on Jan. 15, 1908, asking for elementary information to be used in building gliders. The brothers complied. The remarkable success of this group at Hammondsport, N. Y., in advancing from the kindergarten stage of gliding to the creation of a power-driven airplane within five months, caused some persons to believe that an independent discovery of the secret of flight, eclipsing the Wrights' in celerity of results, had been achieved.

Fortune began to smile on the harassed inventors this year after the defeat of many dazzling hopes. Millions of francs had fluttered before their eyes, and vanished. But now there was a prospect of real money from Uncle Sam. And in the winter the brothers learned that their patents in France had been sold to a syndicate headed by the once-scared-out oil man, M. Deutsch.

"We get half a million francs, Orv!" I hear Wilbur saying. "This time they're real, not the funny ones. One hundred thousand dollars. We can use it. I guess we ought to celebrate. How about some broiled porterhouse steak for dinner?"

The payment was $35,000 in cash and the balance stock. The contract called for an hour's flight in France and the teaching of three pupils. It was agreed that Wilbur would be the one to go abroad to fulfill these terms while Orville would stay at home and look after the deal with Uncle Sam.

In May, 1908, the brothers went to Kitty Hawk, scene of their immortal discovery, to do some practice flying with the 1905 plane, now fitted to carry two persons and with the controls changed so that the pilot would sit upright instead of lying prone.

It was high time for the inventors to show the world what they had, for with near-planes Farman was performing in France and Delagrange hopped nearly eight miles at Rome.

The first time in history that a plane carried two persons was on May 14, when the brothers ascended in turn with a passenger, Charley Furnas, whom they had brought to Kitty Hawk as their mechanic. Orville took Furnas on a jaunt of two and a half miles.

A number of press writers lurked behind the sand dunes during these tests. Among them was Byron R. Newton, later Collector of the Port at New York, whose employer, James Gordon Bennett, proprietor of *The Herald*, had commanded:

"SHOW up those fakers—the Wright brothers!"

This was a difficult assignment for him as for Arthur Ruhl and for Jimmy Hare of *Collier's Weekly*, a veteran war photographer who had kept his nerve amid scenes of carnage, but was so amazed when the unearthly white-winged bird lifted from the sand and roared past him overhead that he forgot to click the shutter of his aimed camera!

On his way back to Dayton to complete the new machine for the Government, Orville scouted the test grounds at and around Ft. Myer, Virginia. This suburb of the national capital had few merits as a pioneer air port. A hazardous course was laid out amid barracks, car lines, telegraph poles, ravines, and wooded hills, with no clear or level spots for emergency landing. With small power and scant altitude, an embarrassed plane would have no chance to glide to safety. Probably a modern pilot with equal equipment would decline to accept the risk. The inventor knew the peril and calmly staked his life on the outcome.

The first formally public flight of the Wright machine in America was made at Ft. Myer on Sept. 4, 1908. It was a very brief try-out. When Orville stayed up four minutes next day, "the crowd went crazy." They had reason to be crazier on September 10 when Orville flew almost an hour in the morning, and in the afternoon circled the parade grounds at 120 feet altitude for an hour and five minutes. The latter was a world record, since Wilbur in France was having motor trouble and no (Continued on page 136)

The one disastrous flight of Orville's career—wreck of the Wright plane at Fort Myer, Va., in 1908. Lieut. T. Selfridge was killed and Orville injured.

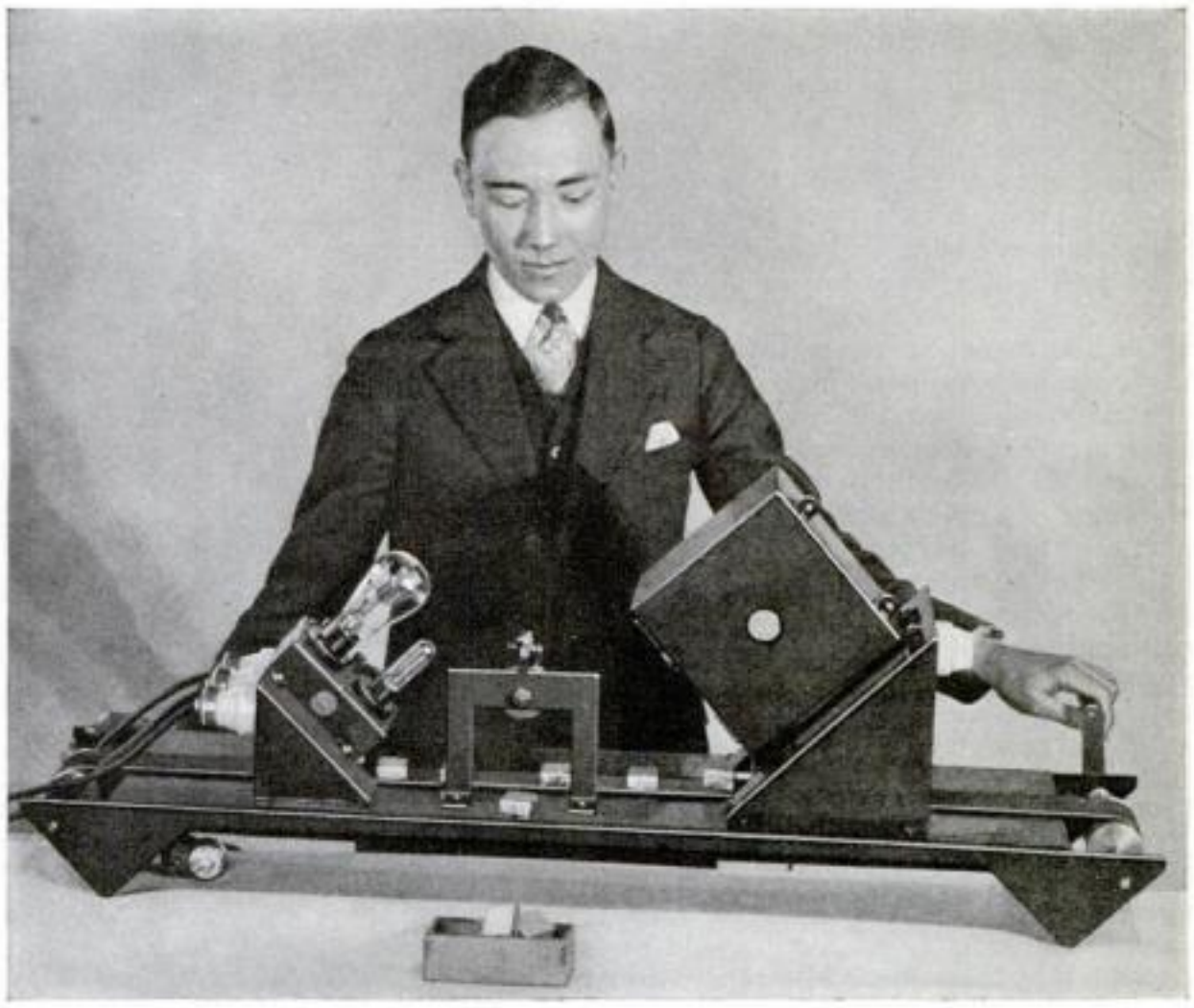
Four days after the accident Orville, in the hospital, was cheered by news of Wilbur's world's record flight.

Strange Eyes That Never Sleep

WHEN Televox, the mechanical man, was first "born," he had the sense of touch. Later he was endowed with hearing, then with a voice. Now it is announced that, thanks to electric eyes, he is to possess the sense of sight as well! Marvelous light-sensitive electric cells, more responsive than human eyes, are being put to amazing new uses in factories, offices, and homes. This absorbing article tells how they can put out fires, detect burglars, sort cigars or yeast cakes, and perform all sorts of magic to relieve us of tedium and drudgery.

By

ARTHUR A. STUART



A robot inspector! When wrapped yeast cakes, on a moving belt, pass under the scrutiny of this "electric eye," those without the proper labels are automatically knocked off the belt as if by magical hands.

ON A New York lecture platform, the other night, a young man tossed a match into a pan containing gasoline and kerosene. From the seething flame arose black clouds of smoke, whirling through an inconspicuous beam of light that passed above them. Then a faint click—and fire-smothering gas belched from a cylinder standing near by. Instantly the fire was out.

An "electric eye" had perceived the first wisp of smoke and had turned in an alarm that set off the extinguisher. So practical is this watchful electrical fire warden that soon it may be widely used to protect large rooms and offices. Indeed, an eastern manufacturer of fire protection devices already is producing the outfits in quantities for commercial use.

Not a new device is the "electric eye," the photo-electric cell. This versatile robot, that obligingly releases a flow of electric current whenever a beam of light falls upon it, sits in a theater's projection room and controls the voice for the talking movies. When photographs are dispatched by wire or radio, the electric eye is called into service. Television would be impossible without it.

But some of its newest magic almost transcends the imagination. It can detect burglars that step past an invisible ray and give the alarm; it rejects defective articles on a moving factory conveyor with uncanny accuracy; it can count people or automobiles with unflagging exactness by the shadows they cast upon it.

Some of these wonders were demonstrated recently by John V. Breisky, research engineer of the Westinghouse Electric and Manufacturing Company, at a meeting of the American Institute. He placed a dozen wrapped yeast cakes on a moving belt. Three of them bore no yellow trademark, and the bright wrapping of tinfoil stood out in marked contrast to the rest.

While Breisky turned a crank, the yeast cakes paraded in single file beneath an electric eye. The first one passed it. So did the second and third, without incident. Then came the fourth, with no label. A little gasp arose from the spectators. Deliberately a metal arm had swung down, without human intervention, and pushed the defective package off the belt!

Repeatedly the device passed properly wrapped packages, to swoop down upon those with missing labels and summarily deposit them in a rejection box. Such a device, Breisky pointed out, may prove of revolutionary importance in industry, where inspectors now must sit all day watching for faulty articles that pass them on a swift-moving belt. An electric eye, that "never gets tired," could replace them with its superhuman infallibility.

Meanwhile another electric eye, stationed at the doorway of the dining room at the New York demonstration, had carefully counted the 200-odd guests as they stepped past the intangible barrier of a ray of light. Every interruption of the beam, which fell upon the sensitive eye, was accompanied by a click of the counter.

If the paper breaks as it passes over the rollers of a paper-making machine, this experimental light-sensitive cell instantly stops the machine. The light source is seen at the right, below the paper.

IN A theater or a public hall such a device would register the number of patrons automatically, even without their knowing it, for it is not necessary to use an ordinary beam of light. Invisible rays, such as "ultra-violet" or "black" light will serve as well. Electric cells may be made that are sensitive exclusively to these rays. And this possibility leads to another sensational application.

From a lamp carefully screened to appear pitch-dark to the eye, an invisible beam of ultra-violet

light may be shot squarely across the front of a safe or bank vault to serve as a burglar alarm. The moment an intruder steps in front of the beam and casts his shadow upon the sensitive cell, upon which the beam is trained, a distant alarm is set off, unknown to him, and the police will arrive in time to catch him red-handed.

Other remarkable devices using the new magic soon are likely to become standard tools of industry. Smoke recorders, now in commercial operation, are only samples of what is to come.

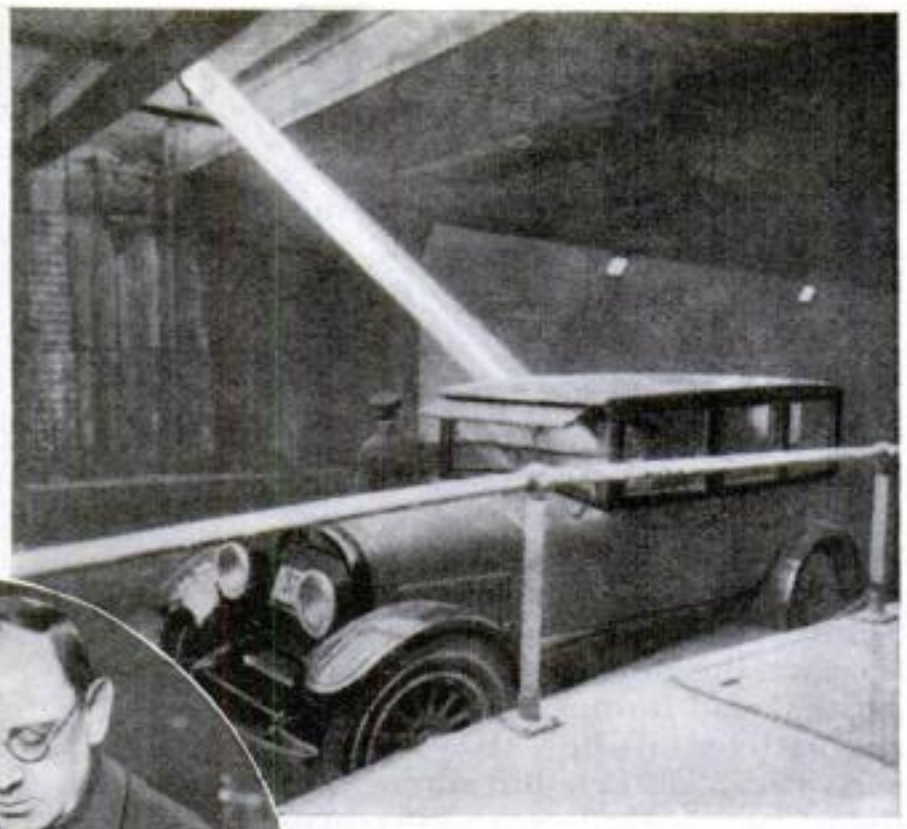
NOT long ago one of the world's largest bank note printers inquired if an "electric eye" apparatus could be built to solve two of its peculiar problems of guarding against counterfeiters. In making bank notes, every scrap of the special paper used must be counted at each stage of the printing to assure that none falls into the hands of rogues who might print spurious notes upon the genuine paper. Engineers responded by demonstrating an electric machine that would automatically register, by their shadows, the number of sheets of paper passing a given point.

The second problem solved was that of matching colors. The more accurately this concern could print notes in uniform colors, the harder it would be to counterfeit them; for a fake of slightly different shade could instantly be detected. Again engineers perfected a light-sensitive cell that could detect and record, in terms of electric current, the slightest differences in the colors of printing inks.

Sorting cigars is an odd job of the electric eye. Buyers of cigars insist that the top row in a box shall be of uniform color; therefore manufacturers have sorted cigars by hand into different colors. Trained workers can distinguish seven different standard shades. Now an electric machine is being developed which will sort cigars of ten different shades.

As this is written, engineers of the Holland Tunnel, the great vehicular tube under the Hudson River that connects New York City with New Jersey, are testing the installation of a newly-developed eye, buried in the pavement, that automatically counts cars passing over it by responding to their shadows. The complete apparatus proposed, a triumph of mechanical ingenuity, will serve the double purpose of registering the total number of cars using the tunnel in a day and showing at a glance just how many cars are in the tunnel at any moment.

How an "electric eye" counts cars passing through the Holland vehicular tube under the Hudson River, New York. The shadow of each car, intercepting a beam of light, causes a photo-electric cell in the pavement to operate a counting machine.



Below: An operator, watching the telltale dial of the automatic counting machine, can tell at all times the volume of tube traffic.

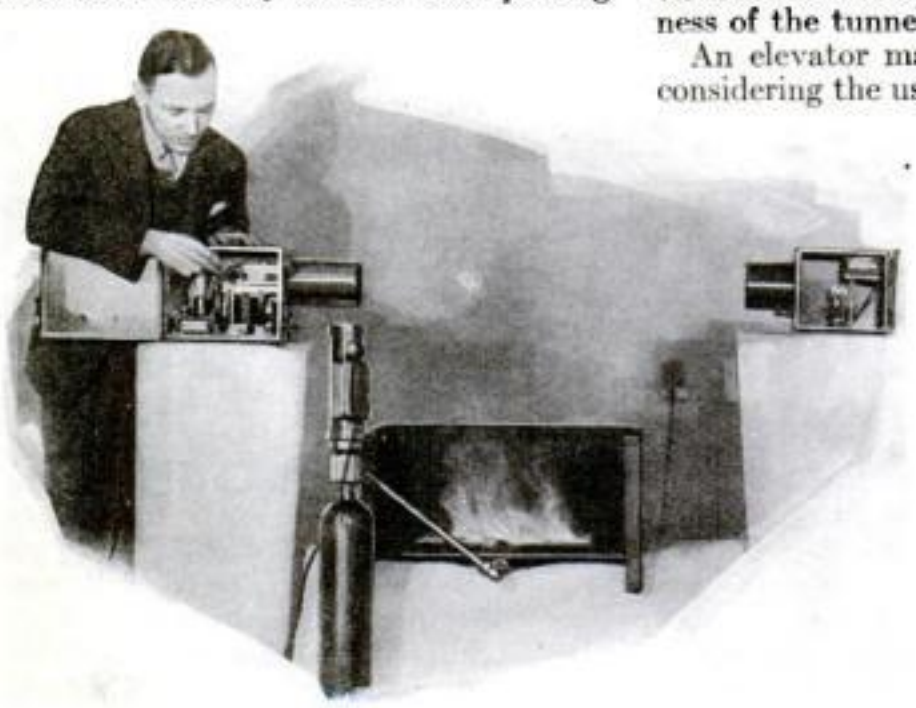
FOR the latter purpose, a special counter will be used, kicked forward by every car passing over an electric cell at the tunnel entrance and backward by each car that, leaving the tunnel, darkens another "eye." Subtracting the cars that have emerged from those that are entering gives the total number in the tunnel, which serves as a constant check on the indicators that register the freshness of the tunnel air.

An elevator manufacturing concern is considering the use of an electric eye that would prevent automatic doors from closing while a person is stepping through the door. A beam of light shot across the entrance would give the means of control. Other novel uses have been suggested. Electric eyes in subways would do away with tally keepers now stationed in underground booths to note the arrival of trains, for trains would literally be made to punch an automatic time clock at each station. In this case the eye would be buried in the middle of the track and operated by a light overhead.

Coupled with a railway signal, an electric eye may safeguard passengers through a new British invention. In London a model railway is being demonstrated in which a train running past a danger signal is stopped without the intervention of any human hand. A beam of light is shot squarely across the track, falling on the sensitive cell; if interrupted by a passing train, the action of the cell is determined by the position of the signal. A "clear" signal permits the train to pass; but a "danger" indication causes the eye to spring into action and, through electrical contacts, to slam on the train's brakes. Such a device, it is pointed out, would make collisions impossible even if the engineer of a speeding train were to lie down in his cab and go to sleep.

Smoke recorders using the eye may now be purchased. Mounted in a smokestack of an industrial plant, they warn of wasted fuel, as indicated by the smoke, and of air pollution, either by making a record on a chart or by ringing an alarm bell when smoke thickens.

In every one of these applications, the "electric eye" itself is a small glass bulb resembling an ordinary radio vacuum tube. One side of the bulb is coated with a thin film of light-sensitive metal—such as potassium, sodium, or caesium. This is the coating that gives the bulb its magical properties, for when a beam of light falls upon it, a stream of electrically charged particles shoots from this coating to a ring of metal at the center of the tube. If electric wires are connected to both the coating and the metal ring, a current flows between them as long as the light beam keeps the space filled with the charged particles. Coupled in an electric circuit, such a "photo-electric cell," as engineers know it, performs all the wonders that have been described, for it makes and breaks the circuit in response to light and shadow. In inspecting yeast cakes, for instance, the light reflected by a tinfoil wrapper actuated the cell and, through it, an electric rejection lever. In counting persons who interrupt the light beam, the opposite effect occurs. The electric circuit is (Continued on page 152)



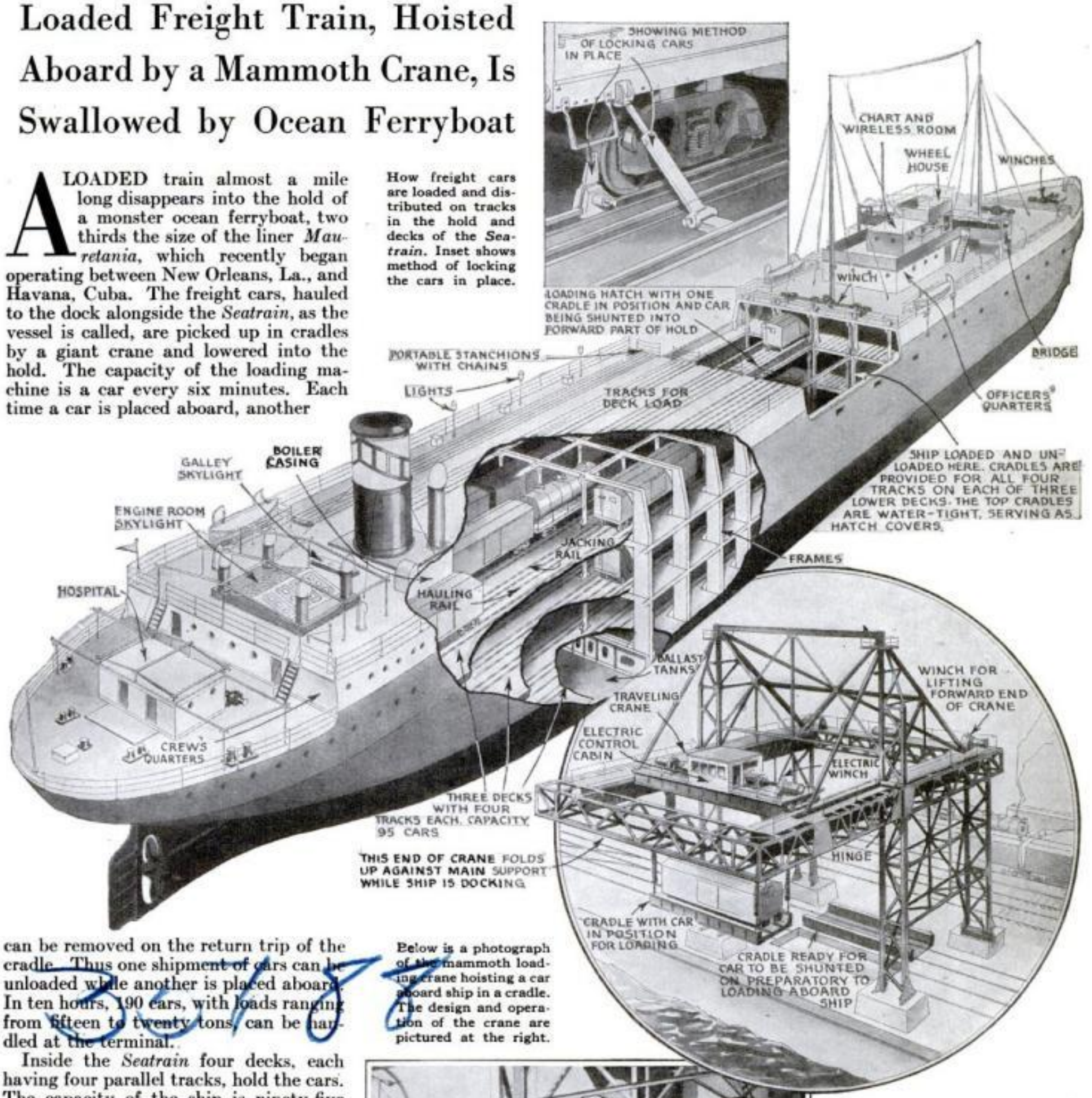
A robot that puts out fires, demonstrated by John V. Breisky, Westinghouse engineer. When he tosses a lighted match into a pan of gasoline and kerosene, the smoke is detected by an electric eye (at left) illuminated by light beam (right). It automatically releases a stream of fire-smothering gas which extinguishes the flames.

Steamer Carries a Mile of Cars

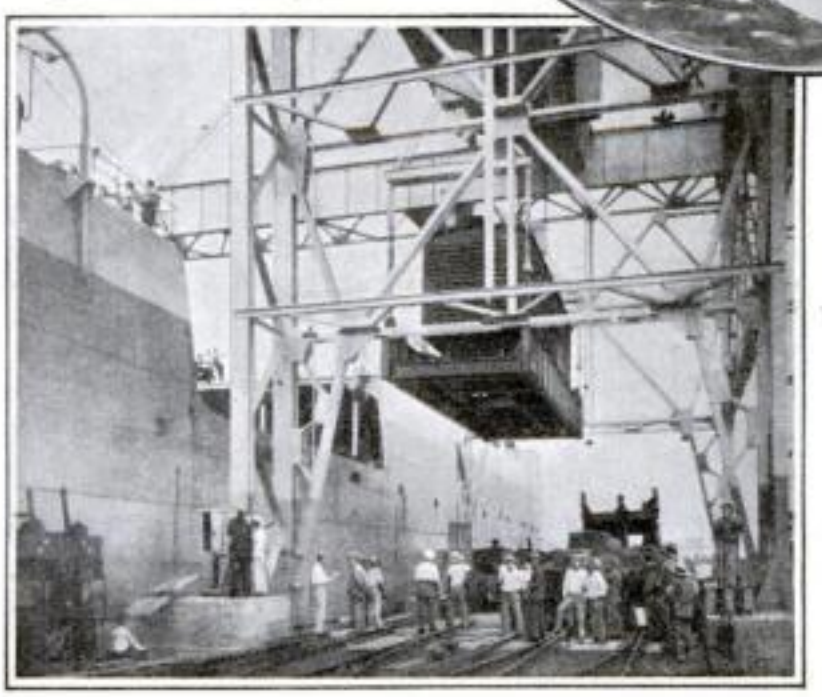
Loaded Freight Train, Hoisted Aboard by a Mammoth Crane, Is Swallowed by Ocean Ferryboat

A LOADED train almost a mile long disappears into the hold of a monster ocean ferryboat, two thirds the size of the liner *Mauretania*, which recently began operating between New Orleans, La., and Havana, Cuba. The freight cars, hauled to the dock alongside the *Seatrain*, as the vessel is called, are picked up in cradles by a giant crane and lowered into the hold. The capacity of the loading machine is a car every six minutes. Each time a car is placed aboard, another can be removed on the return trip of the cradle. Thus one shipment of cars can be unloaded while another is placed aboard. In ten hours, 190 cars, with loads ranging from fifteen to twenty tons, can be handled at the terminal.

How freight cars are loaded and distributed on tracks in the hold and decks of the *Seatrain*. Inset shows method of locking the cars in place.



Below is a photograph of the mammoth loading crane hoisting a car aboard ship in a cradle. The design and operation of the crane are pictured at the right.

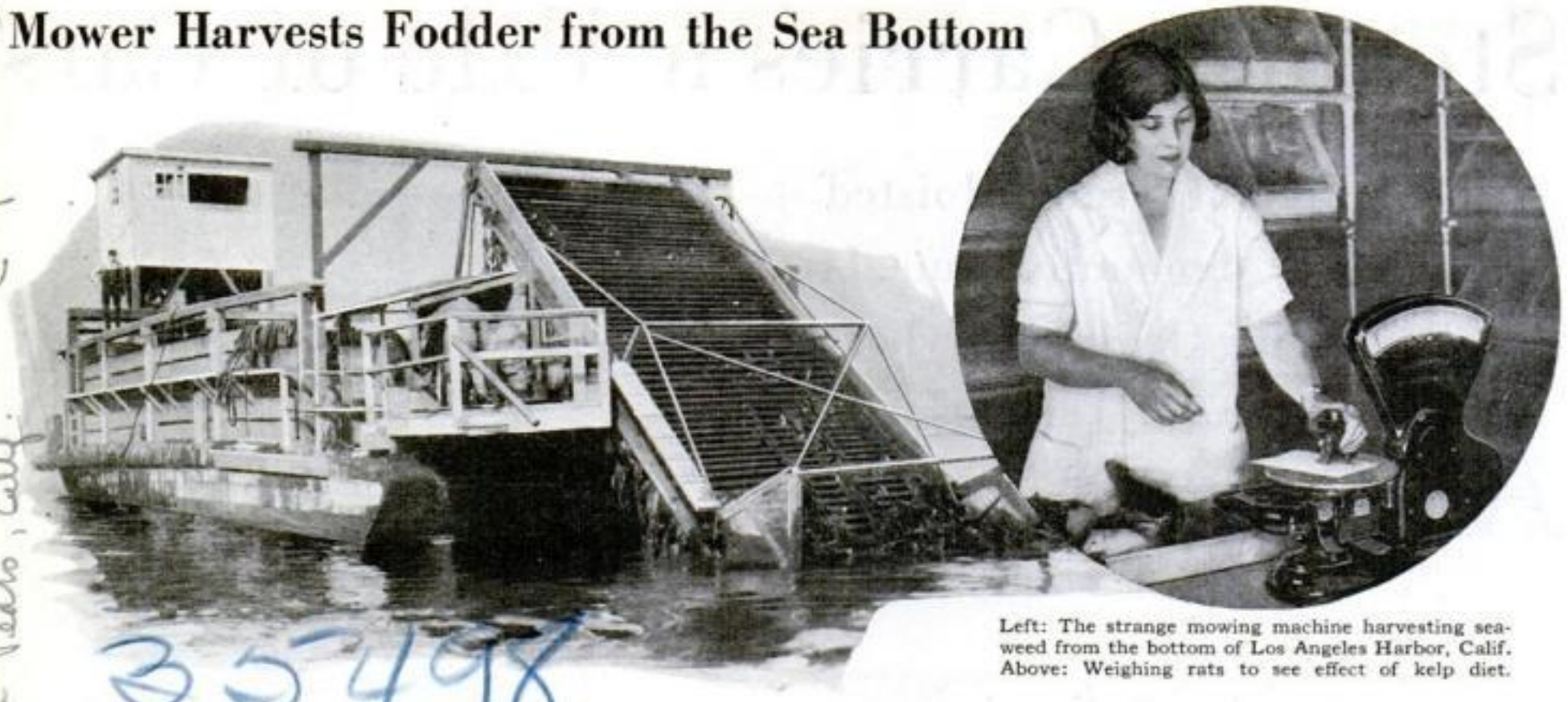


Inside the *Seatrain* four decks, each having four parallel tracks, hold the cars. The capacity of the ship is ninety-five cars, virtually a train a mile long. They are distributed in such a manner as to provide the best balance during the voyage. Twenty-six are placed in the hold, twenty-six on the second deck, thirty on the upper deck, and thirteen lightly-loaded cars on the superstructure. When they are lowered into the hold to the level of the track, a mechanical puller draws them into place. To prevent the cars from rolling or tipping in heavy seas, the wheels are braced at each end by special bumpers, while steel arms, locked against the side of the cars, prevent them from rocking.

This Leviathan of ferries was built in Scotland at a cost of about $700,000. Its length is 427 feet six inches; its width sixty-two feet three inches. Its steam engines, burning oil fuel, develop 3,000 horsepower and drive the single-screw vessel at a service speed of eleven knots an hour.

The new *Seatrain* service allows freight to be loaded in cars at factories in American cities located at a distance from the sea and sealed until it reaches its destination in Cuba. It saves the expense of handling and rehandling the contents of freight cars at the steamship piers and protects the packages from breakage and pilfering.

Mower Harvests Fodder from the Sea Bottom



Left: The strange mowing machine harvesting seaweed from the bottom of Los Angeles Harbor, Calif. Above: Weighing rats to see effect of kelp diet.

MOWING the underwater meadows of the sea is part of a process which is providing a new kind of fodder for livestock. Kelp, formerly collected for the extraction of its iodine and potash before more economical methods of obtaining them were devised. now is being harvested, ground, dried, and fed to farm animals to supplement the grain and hay harvested on solid ground. This undersea vegetation is employed also as a fertilizer.

A unique marine mowing machine for cutting the kelp was demonstrated recently in Los Angeles Harbor, Calif. It consists of a scow, at the prow of which a machine resembling a hay loader descends into the water. This is an inclined frame over which passes an endless belt of spiked crosspieces. At the bottom sharp blades shear off masses of the seaweed. These catch upon the crosspieces and are elevated by the moving ladder and deposited on the scow. The ocean harvest, as it comes dripping from the water, is piled in the hayracklike deck compartment of the scow.

This sea-bottom food, rich in iodine and potash, is expected to prove a valuable addition to the diet of farm animals, and even to rabbits and poultry. Tests of its beneficial effect upon different kinds of animals are being made in a Los Angeles laboratory, where rats are being fed the new diet. The dried seaweed is added to their rations in various quantities, and at regular intervals the animals are subjected to an examination and weighed to see how the food is agreeing with them.

Fishless "Cod Liver" Oil Made from Yeast

COD liver oil is now being produced without the help of codfish by a process perfected by Dr. Charles E. Bills, of Evansville, Indiana. The power of cod liver oil to build bones and prevent rickets is attributed to the presence in it of a chemical substance, ergosterol. This substance is also found, in an inactive state, in yeast and in certain fungi, and can be made active by exposure to ultra-violet rays, either from the sun or from artificial sources. The yeast ergosterol is then dissolved in peanut and cottonseed oils.

Besides being without an unpleasant taste, the new product, it is said, will not spoil or become rancid.

No Sterilization by Radio

BY A false analogy between radio waves and X-rays some alarmists have been concerned as to the effect of radio upon the fertility of the human race. It is well known that X-rays have the property of causing sterility, but experiments on mice by Drs. Nemours-Auguste and Martin, of Paris, who recently reported their conclusions to the French Academy of Sciences, indicate that radio waves have no such effect.

The Air Above Your Home Is Yours, Say Experts

IF YOU own a piece of land your ownership extends down to the center of the earth and up to the sky, according to the National Association of Real Estate Boards. You may sell or lease the air above your land property, it contends.

Many legal authorities, however, are modifying their belief that a landowner can stop strangers from flying over his land. They insist the air is analogous to navigable water and that flying cannot be interfered with as long as it does not injure the property in any way or prevent the owner from using it.

Italy Originator of Ice Cream?

THE honor of originating ice cream is claimed by Italy. Records at Florence are said to show a thriving ice cream business flourished there in the sixteenth century and, when Catharine de Medici journeyed from Florence to France, it is recorded that she took her own "gelateria," or freezing plant, along.

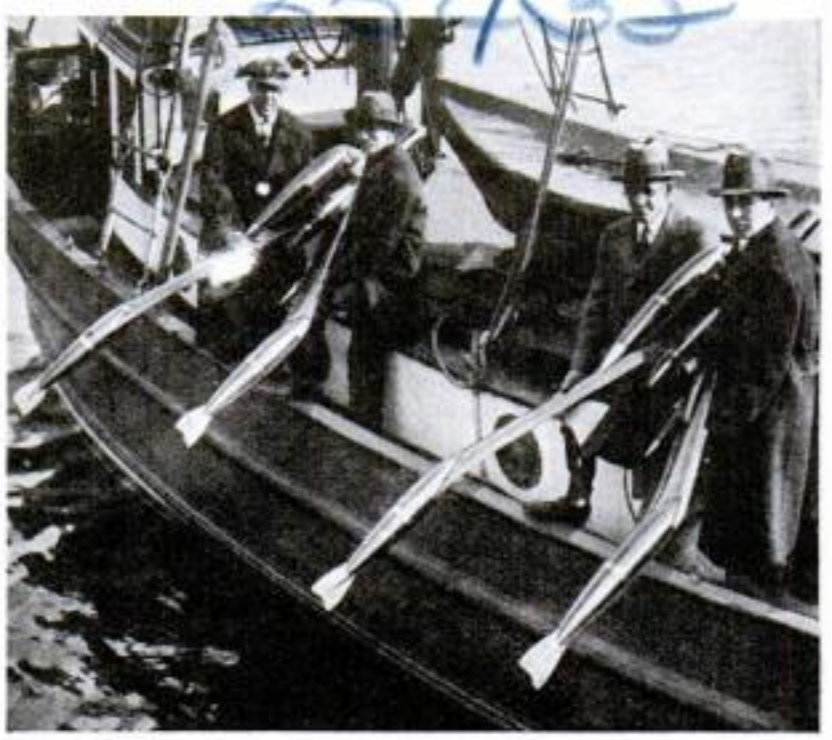
By 1775, the dessert was known in France, England, and Germany. The first advertisement of ice cream in New York appeared June 8, 1786. The delicacy was introduced to Washington by the widow of Alexander Hamilton at a dinner in honor of President Jackson and the first wholesale ice cream business was started by Joseph Fussell, of Baltimore, in 1851.

"Wishbone" Tubes Detect Approaching Vessels

A "FLOATING wishbone" is the latest safeguard for vessels against submarines and other ships approaching through fogs. The strange detecting instrument, resembling a robot with bow legs, is formed of a combination of torpedo-shaped tubes. It is lowered into the water attached to an electric cable.

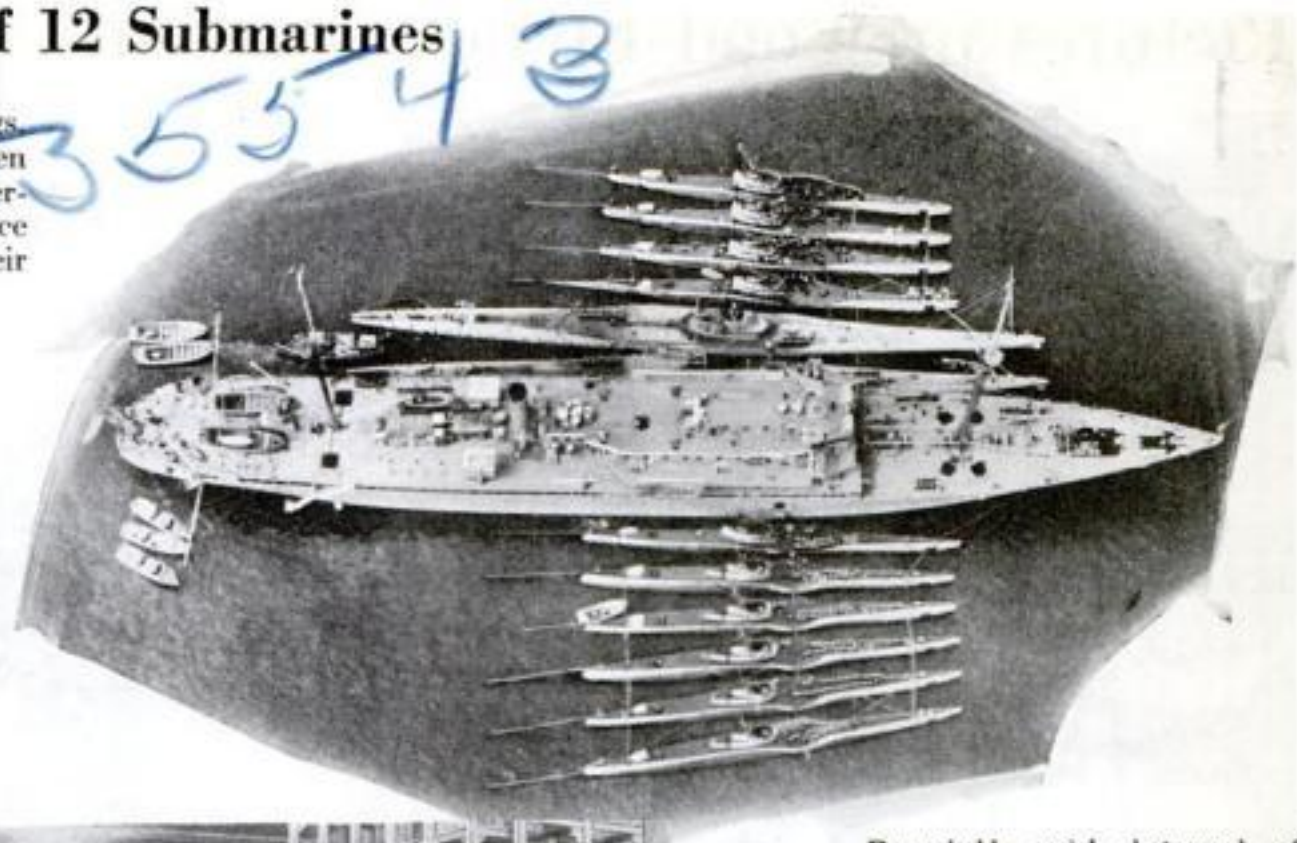
When a submarine or other vessel approaches within a certain radius, it sets up vibrations in the sensitive instrument, which sends electrical impulses through the wire to recording instruments on board the ship to which it is connected.

Two of the detectors were tried out with success recently at Boston, Mass. Taken beyond Boston Light on board a power boat, they reported the approach of every vessel. In case of war, the inventor claims, the instrument would detect submarines approaching troop ships.



Launching two of the detectors from a power boat during recent tests at Boston, Mass. They signal approach of another vessel.

Mothering a Brood of 12 Submarines



Remarkable aerial photograph of the mother ship *Holland* with her brood of submarines in the Pacific.

LIKE a hen with a flock of ducklings, the *Holland*, mother ship of a dozen U. S. submarines, watches the underwater boats disappear below the surface of the ocean and waits in position for their return. The vessel, named after J. P. Holland, the American inventor of the submarine, "mothers" ten of the speedy little "S" type submarines and a pair of the "grown-up" undersea ships of the "V" type.

How the vessel appears with its steel brood clustered beside it is shown in the photograph taken from a plane circling overhead. The crews are seen standing at attention in readiness for the signal for maneuver practice.

The *Holland* has been stationed in the Pacific, off California.

Blades Cost Shavers $38,000,000 a Year

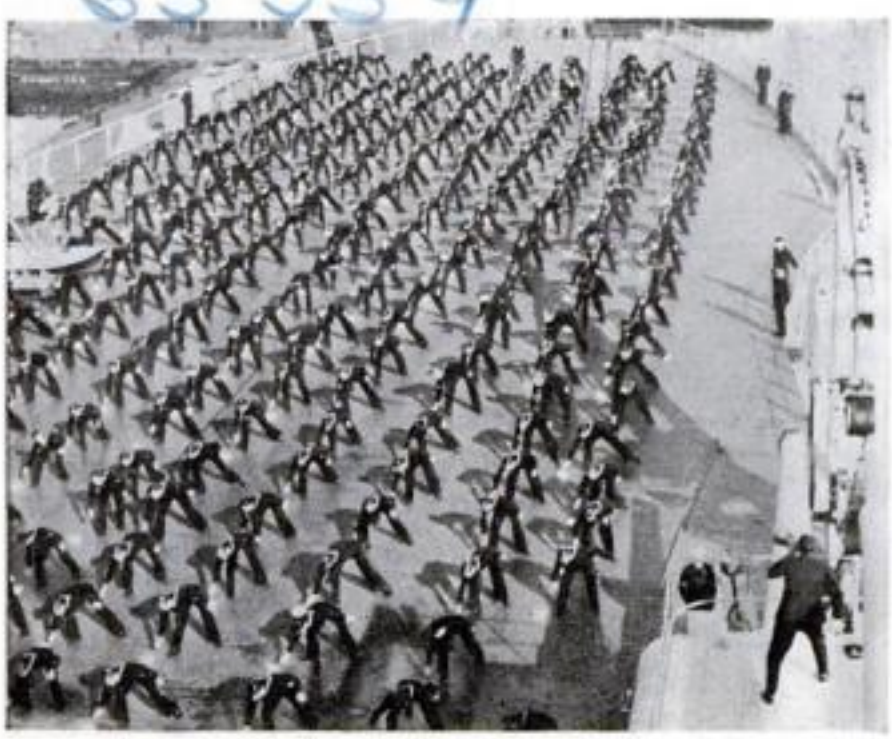
MORE than $38,000,000 worth of safety razor blades are made in the United States each year to replace those dulled by all kinds of beards, a report of the Department of Commerce reveals. During the same period, $1,250,000 worth of razors to hold the blades came from the factories.

That straight-edged razors are still in demand is shown by the fact that more than $300,000 worth are manufactured every twelve months. Pocketknives reach a total of more than $5,000,000, while scissors and shears are only $1,000,000 behind.

How Airplane Carrier Crews Keep Fit

MEN who care for the war eagle nests of the U. S. Navy have to keep in good physical condition. Early every morning the men of the airplane carrier *Saratoga* line up on the huge landing deck of the vessel for calisthenic exercises.

The *Saratoga*, sister ship to the *Lexington*, can carry forty combat planes and thirty-two bombing machines. It is electrically driven, and all the turrets, bridges, and funnels are placed at one side, leaving a spacious deck clear for the planes to land and take off. The electric current used to run the *Saratoga* could light a city the size of Boston, Mass.



One of the world's biggest exercise classes going through its morning drill on the spacious upper deck of the U. S. airplane carrier *Saratoga*.

The inventor with a model of the new elevator, showing how it transfers grain from ships to railway cars.

New Grain Elevator Weighs Cargoes Automatically

DRAWING a stream of grain from the hold of a vessel on one side, automatically weighing it, and loading it into freight cars on the other side, a new elevator, designed by Joseph A. Schmitz, of Chicago, Ill., is expected to save time and money for grain dealers. It will allow steamers on the Great Lakes to transfer their cargoes directly into the railroad cars by way of the elevator, at the same time keeping a record of the amount of grain transferred.

An inclosed conveyor, which lifts the grain into the bins of the elevator, can be raised and lowered as one compartment of the ship is emptied and the vessel is warped ahead for an attack upon the next compartment. A model of the invention, shown in the picture at the left, has been exhibited in the weighing department at the Chicago Board of Trade, where the inventor is weighmaster.

Onion's Light Photographed

AN ONION supplied the light for an amazing photograph recently reported to the Society of American Bacteriologists.

To prove a theory that growing plant tissues emit ultra-violet light capable of stimulating cell divisions and growth, Ralph R. Mellon, N. von Rashevsky, and E. von Rashevsky, of the Institute of Pathology, Western Pennsylvania Hospital, Pittsburgh, photographed the light.

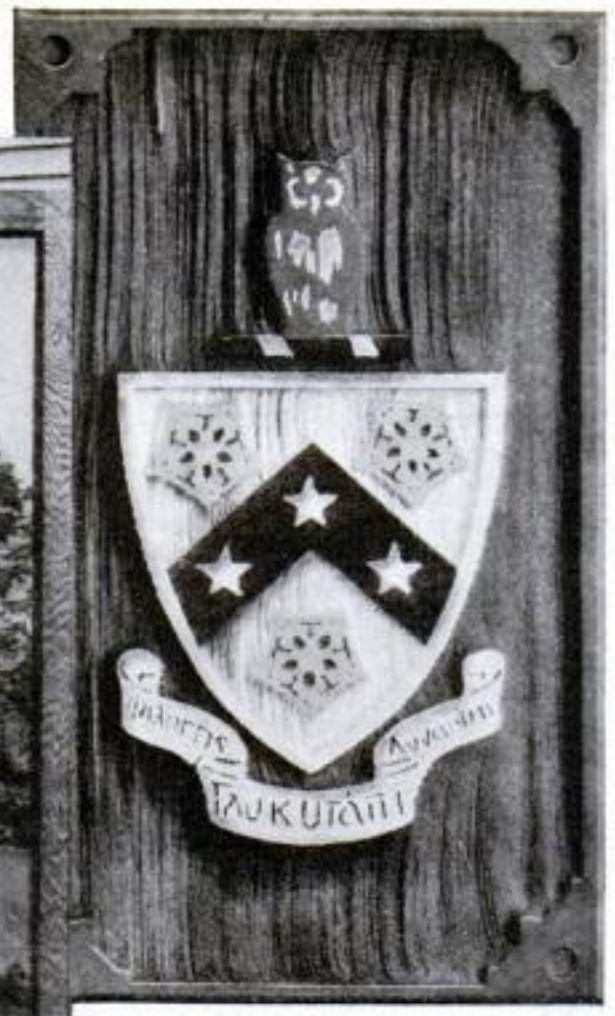
Three Men Have Wild Ride in Runaway Balloon

A RUNAWAY balloon recently carried three Germans on a wild, uncharted flight across Holland and the North Sea and landed them near Aberdeen, Scotland. The occupants were a farmer, a dentist, and a doctor. Soon after taking off, near Leipzig, they discovered that the valve for releasing gas to bring them to earth had stuck, and that they were at the mercy of the elements.

During the night, they were swept over the North Sea and driven along the coast of England. A shift in the wind would have carried them out over the Atlantic. At three o'clock in the morning, they sighted a light, which proved to be Aberdeen, but the gale whirled them away in the direction of the snow-covered crags of northern Scotland. As the hydrogen gas seeped through the envelope of the balloon, it sank nearer the earth, the basket finally catching in a tree on the top of a high hill. This allowed the occupants to climb to the ground in safety.

Pictures in Wood Etched by Sand

Two beautiful mountain views etched by sand in Douglas fir. The wood frames also are figured by etching.



A fraternity crest etched in straight-grained cedar lumber by the new process. Stencils were used in order to make the crest stand out in bold relief.

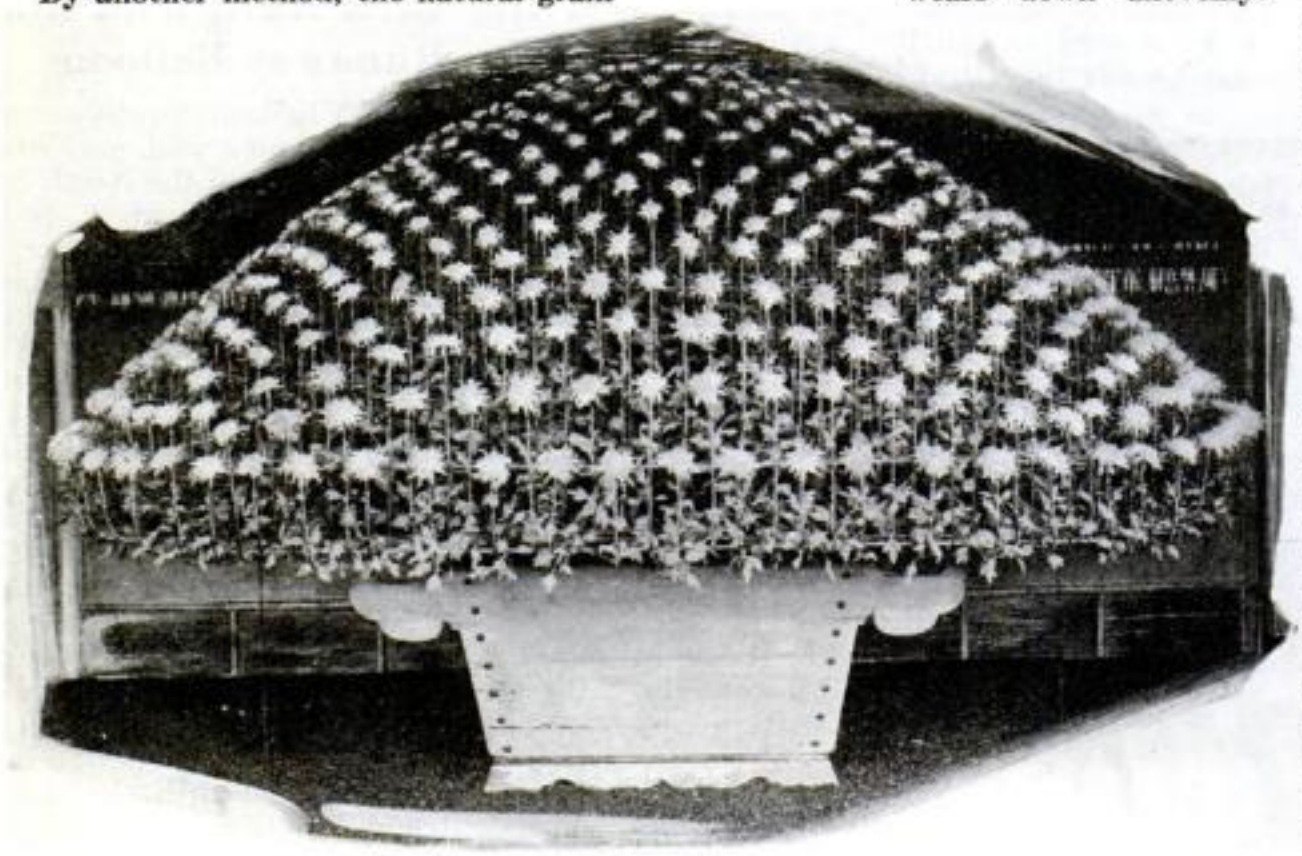
FINE grains of sand etch pictures on large panels of Douglas fir in a new process developed recently by a Longview, Washington, lumber company. The pictures, called xylograves, will decorate the waiting room of a railway station in the Pacific Northwest.

In making the unusual pictures, stencils are placed over the panels before they are submitted to the etching treatment. A stream of eroding sand grains is then played over the panel, eating away the soft grain deeply and accentuating the hard, but not affecting the wood covered by the stencils. Thus, when the etching process is complete and the stencils removed, the design stands out in relief with a background of raised and lowered lines of wood. Life, color, and perspective are added by stains and wax.

By another method, the natural grain patterns found in slash grain Douglas fir are etched into relief. This process scours out the soft wood, emphasizing the innate artistry of the hard grain figures. It also gives the completed panel a worn, mellowed effect similar to that of pieces of driftwood.

The scenes depicted in the panels for the railway station include a logging scene and two mountain views, one of Mt. Baker, the other of Mt. Shuksan, both in northern Washington. They are framed with fir figured by etching.

Crests, fraternal insignia, and panels of ornamental scrollwork of unusual appearance are created by a similar process on cedar lumber. The cedar is adaptable to exceptionally deep etching that emblazons the design in high relief against background of straight grain which wears down unevenly.



The wonderful chrysanthemum plant, with its pyramid of 523 blossoms, all growing from a single stem. It was grown in Japan. A framework of bamboo holds the stalks to form the pyramid.

Women Drivers Have More Accidents, Survey Shows

IF YOU ride with a woman driver, your chances of being in an accident are three times as great as if a man is at the wheel. At least that is the conclusion arrived at from a survey covering eleven months, made recently by Dr. Morris S. Viteles, Assistant Professor of Psychology at the University of Pennsylvania, Philadelphia.

The accident records of a taxicab company employing 150 women and 2,000 men were examined. All the drivers operated the same kind of cars under similar conditions and had the services of the same corps of shop mechanics. Yet the records showed that the women drivers were in three times as many accidents, in proportion to their number. These accidents, however, were rarely as serious as the ones occurring to taxis driven by the men. On the other hand, Dr. Viteles pointed out, the overcautiousness of the women often resulted in crashes by other drivers.

523 Chrysanthemums Bloom on a Single Stem

FIVE hundred and twenty-three chrysanthemums growing on one plant! With the nourishment brought from the ground by a single stem, a prize plant, belonging to the royal family in Japan, produced a whole roomful of blooms. A framework of light bamboo held the stalks in such a position that the plant appeared to be a huge pyramid of shaggy flowers.

Japan is noted for its chrysanthemum beds, some of the finest being found in the Hihiya Park, in Tokyo, where the unusual plant with its half-thousand blooms attracted crowds when it was exhibited recently. The chrysanthemum originated in the Orient. They were first found in China.

Back Yard Observatory Built of Wall Board

BY TAKING a few steps from his back door, Robert E. Millard, of Portland, Oregon, enters a remote world of stars and planets. He has constructed in his own back yard what he believes to be the only privately owned observatory on the Pacific coast. Housed within it is a four-inch refracting telescope which brings many heavenly bodies almost within hailing distance.

The building was constructed of fiber wall board nailed to a framework on a concrete foundation. The construction of the dome was simplified by the use of this material, as the fiber boards, cut into sections, could be bent and fastened to the rounded framework of the roof. Millard is a musician whose hobby is astronomy.

Makes Coats You Can Wear Either Side Out

A LONDON tailor has invented a reversible coat that can be worn right-side-out or inside-out. After two years of experiment, he discovered a means of constructing the garment so it has the appearance of a well-tailored coat whichever side is exposed.

In a demonstration recently, he pulled on a smart, double-breasted blue nap overcoat. Then, reversing it, he was clad in a well-cut gaberdine raincoat with a belt. He says he can make a twin garment of a raincoat, a dinner jacket, a suit coat, or an overcoat.

Curious Apartment House Built by Nature

THE wind was the architect of a strange apartment dwelling for members of a semisavage tribe in East Turkestan. Under the high columns and domes of a wind-eroded cliff of solid stone in the interior of this wild, infrequently-visited country, lying in Central Asia between India and Mongolia, the tribesmen have hollowed out "apartments," most of them consisting of but a single room.

The towering domes of these huge cliff dwellings of tribesmen in East Turkestan were carved from the rocks by the winds of centuries.

The holes in the base of the cliff in the picture are the doorways leading into these rooms.

Our Best Snake Stories Are Wrong, Says Expert

MANY of the popular beliefs about snakes are wrong, according to Karl P. Schmidt, assistant curator in charge of reptiles at the Field Museum, Chicago. The belief that counting the rattles of a rattlesnake will tell its age is rarely substantiated by fact, he declares. Equally erroneous are the ideas that a rattlesnake will not cross a horsehair rope nor a chalkline; that it lives at peace with prairie dogs, and that it is possible to be poisoned by contact with an old broken fang from a rattler.

Alcohol, instead of curing a snake bite, he says, becomes an active aid to the poison. The reason people who take whisky for snake bites often recover, he declares, is because most snakes are not poisonous and frequently people imagine they have been poisoned when they have not.

Other widely-believed "snake stories" which he disposes of are the tales about "hoop snakes" that take their tails in their mouths and roll like hoops; "blow snakes" that poison with a blast of their venomous breath; "glass snakes" that break into pieces when struck with a stick; and "milk snakes" that suck milk from cows.

Its Front Door Is a Tunnel

A QUEER "cliff swallow dwelling" has been built at Rottingdean, near Brighton, on the southern coast of England, by a sea captain. Thirty-five feet below the floor of the main building a doorway leads into the face of the sea cliff, connecting with a tunnel and stairways that rise to the house above. This permits an entrance and exit directly from and to the ocean beach.

The design of the building itself is unique. The center of the roof is in the shape of a dome. In its general plan, the house suggests a vessel with one side to the sea. Some of the windows, as can be seen from the illustration below, are designed to resemble portholes; and the decorations of the dwelling are similar to those on a ship.

Large windows, facing the water, afford a clear view of the sea, so the outlook of one sitting inside the structure gives the impression of being on the upper deck of a steamship.

The queer cliff dwelling of a British sea captain on the south coast of England. The "front door" at the base of the cliff leads to a tunnel connecting with a stairway to the house 35 feet above.

Bus Runs on Extra Wheel If a Tire Goes Flat

WHEN a front tire blows out on a new type motor coach, recently demonstrated in Los Angeles, Calif., the passengers are guarded from accident by a solid steel auxiliary wheel attached to the axle behind the main wheel.

There are two of these emergency wheels, one on each side. They are fitted with solid rubber tires and are two inches smaller in diameter than the main ones. Thus they touch the road only in the event of a blow-out or puncture, when the smaller wheel holds the deflated tire from the ground sufficiently to prevent rim cutting while the heavy coach is being brought to a stop.

Advocates Prohibition of Teeth-Decaying Food

IF DR. JOHN P. BUCKLEY, a dentist of Hollywood, Calif., has his way, a new amendment to the Constitution will prohibit eating foods that decay teeth. At a recent meeting of the Chicago Dental Society, he declared that the diet should be limited to rough foods which stimulate the gums and supply needed vitamins to the blood.

At the same meeting, Dr. E. E. Dalton, of Chicago, estimated that Chicagoans wear $10,000,000 worth of gold teeth, and that $15,000,000 in gold teeth is buried annually in the United States.

Bullfrog Army to Fight Alaskan Mosquitoes

BULLFROGS from Oregon are going to the aid of Alaska in their fight against mosquitoes. Alaska has been a mosquito paradise because the country has contained no frogs, it is said. The vicious stinging of the insects caused misery to many "sourdoughs" in the early days, and still bothers inhabitants in summer.

The large web-footed Oregon frogs are green and brown in color. They have gained wide fame as the natural enemy of the mosquito. An army of the croaking insect fighters will be let loose in one of the Aleutian Islands by J. H. Wagner, Superintendent of the Alaska division of the U. S. Bureau of Education. If they clean up the pests there, others will be put to work on the mainland.

Auto Engine Loses Power in Damp Weather

DOES an automobile engine give more power in dry or damp weather? Many motorists are under the impression that the motor works best when the atmosphere is humid. Recent laboratory tests, however, showed that power decreases as humidity increases. When the humidity is high, the combustion rate is slowed up, resulting in apparently smoother engine operation.

To obtain the most power available under humid conditions, says A. W. Gardiner, of the General Motors Research Laboratories, who made the test, the spark should be advanced considerably.

Africa Hunter Brings 'Em Home on Motorcycle

A MACHINE that can outrun beasts of the jungle is adding a new thrill to big game hunting in Africa. Donald Ker, an Englishman living at Gilku, in Northern Nigeria, recently introduced the motorcycle as a mount for his hunting trips in the Sudan. Already he has bagged seven leopards by use of his speedy machine. Each time, after the big jungle cat was shot, he lifted it across the handlebars of his motorcycle and drove it in to Gilku.

The motorcycle can follow paths and trails that would be impassable for an automobile, Ker explains, so it is an ideal mount for African hunters who need a combination of speed and the ability to get off the traveled roads. By invading the jungles with his motorcycle, Ker has been able to cut traveling time considerably and get away on week-end hunting trips.

Astronomers Say the Moon Is Brown; Mars Green

THE moon is not white, it is brown; Mars is not red, it is green!

These are the latest suggestions of astronomers. A committee of the Carnegie Institution, in Washington, D. C., reports that the apparent silvery whiteness of moonlight is due to contrast with the darkened sky. The actual color of the moon, they believe, is the dull brown of weathered rocks. This suggests that the surface of the satellite may have been weathered by oxidation, at some previous time, although the moon is known to have no atmosphere now.

Mars, according to E. J. Gounod, of the Amateur Astronomers Association of New York City, may be covered with green vegetation like the earth. The reason it appears red, he says, is that the light rays have to pass through the atmospheres of both Mars and the earth before they reach our eyes. These atmospheres filter out the blue and green rays but allow the red rays to pass.

The three reasons most often given for the red color of Mars are that the planet is "rusty" with iron rust, that its soil and rocks are red, or that it has red vegetation.

"Skinny" Men Smartest, College Tests Show

DO THIN men have the most brains?

Recent investigations at Lafayette College, Easton, Pa., seem to answer "yes." It was found that those who were underweight stood higher in their studies than those who were normal or overweight. The study was made under supervision of Professor H. E. Brown, Director of Physical Education.

The seven hundred students who were tested were divided into three groups—underweight, normal, and overweight. When their school records were examined, it was found the superiority in the standing of underweight men over the normal men was about the same as that of the normal men above the overweight men.

Lock for Emergency Brake to Prevent Runaways

A NEW type of automobile lock has been designed to prevent thieves from towing away the machine and to guarantee that the car will not run away when it is parked on a hillside. It locks the emergency brake lever so the brakes cannot be released until the owner returns. Turning the key in the lock after the emergency lever has been pulled back operates a ratchet which pushes a rod down into a hole in a special quadrant. This holds the lever in position until the key is turned again, lifting the rod. The device is especially designed to hold a heavy truck on a down grade.

Emergency brake lock. Turning key inserts plunger into a hole in a quadrant below.

Artist Weaves Portraits from Human Hair

HUMAN hair is the "paint" used by G. Boruchoff, a Russian artist, to form pictures which, at a first glance, are said to be indistinguishable from oil paintings. When he was ten years old, Boruchoff was apprenticed to a hairdresser and continued in this work for twenty-two years. During that time he had the idea of making hair pictures and made several attempts with small success. While a war prisoner in Germany, he spent his leisure in practice, and after the war began exhibiting his pictures which, in recent years, have aroused much interest in Europe.

As he works, he blends the various shades of hair together on his palette, as an oil painter mixes colors. His canvas is a piece of silk or linen cloth. His brush is a fine knitting needle. He knits the strands of hair to the cloth by a method which, he explains, is similar to that used in making the famous Gobelin tapestries.

Boruchoff has expressed fear that the bobbed hair fashion may kill his art, as he needs long strands for his work.

A Substitute for the Bulky Golf Bag

TO AVOID the trouble of bending over to pick up a golf club bag and of pulling a club from its interior, E. R. Barany, a Madison, Wis., golfer, has designed a new coverless carrying rack which stands like an easel, holding the clubs in a row like billiard cues. While the rack is being carried, the clubs are locked in place, each in a separate compartment, by a hinged bar that holds them with rubber cleats. When the player is ready to choose a club for the next shot, this bar is released by pressing a button operating the locking catch. Only a fifth of the usual time is needed to select a club with his device, the inventor claims.

The stand is carried by a rubber grip on the side of the frame. When it is placed on the ground, a light metal support swings out to hold it in a slightly inclined position. The material of which the device is constructed, says the inventor, is a composition combining great strength with extreme lightness. Seven clubs and four golf balls fit into the rack.

Made of light metal, the club rack stands on its own legs. Note the grip at side of frame.

Golf Club Picks Up the Ball

A RUBBER suction cup attached to the top of the putter handle is designed to do away with the bother of stooping to pick up golf balls on the green.

When this pick-up is pressed down over the ball, it fits snugly around it, holding it fast. The cup can be removed easily if it is in the way when the club is in use.

How a rubber suction cup on the club lifts the golf ball.

Rubber-Band Luggage Rack Does Double Duty

A FLEXIBLE luggage carrier for automobile running boards serves the double purpose of holding luggage and, when not in use, of protecting the paint above the running board from being scuffed by persons entering the machine.

It consists of a wide band of rubber attached to the body just above the running board so that it can be stretched out to hold packages and luggage during a trip. When the luggage is removed, it snaps back in place.

Because of its resiliency, the maker says, it holds the luggage securely and prevents bouncing. The holders are manufactured in a variety of colors to match the shades of different cars.

They're Taking the Chill Out of Ice Cream

IF YOUR mouth aches after eating cold ice cream, you may soon be able to buy "warm" ice cream to suit your taste. A research chemist, G. D. Turnbow, formerly connected with the University of California, has invented a process of making ice cream at a high temperature.

The confection produced by the Turnbow process has smaller crystals and is made by rapid freezing. The product, demonstrated recently before a convention of ice cream manufacturers in California, is expected to prove popular during winter months when the consumption of ice cream usually falls off.

Talk to Byrd from Panama

MEN in furs, standing on the ice of the Antarctic, talked with men perspiring under the tropical sun recently when communication was established between members of the U. S. Army stationed in Panama and the Byrd expedition at the Bay of Whales. The words sped from Balboa, Panama, to the Antarctic wastes and back.

The feat is considered a triumph for the new type of low-powered, portable short-wave set designed for the Army Signal Corps and used in the experiment. Three small storage batteries operate the transmitter of the portable set, which has been used to communicate with stations up to 8,000 miles distant.

Millions of Reptiles Killed for Leather

TO SUPPLY the demand for reptile leather for shoes, luggage, and hand bags, more than a million alligators, a million other lizards, and 800,000 snakes were killed last year. The alligators come chiefly from Mississippi, Louisiana, Florida, Mexico, Central America, Venezuela, and Madagascar. The Amazon River, of South America, contains more alligators than any other stream in the world. Many of the lizards come from far-off Borneo and Java, while the Dutch East Indies supply most of the python skins.

Few farms are maintained to raise reptiles for their skins. The growth of large snakes is too slow to make such a venture profitable. Before they are killed, the snakes must be from six to twenty feet long. The average age at which alligators are killed for their hides is estimated to be fifty years.

Three Hundred Times as Sweet as Sugar

RARE perfumes, flavorings, and sweets are being extracted from common corncobs in the chemical laboratories of Iowa State College by Dr. Henry Gilman and A. P. Hewlett, organic chemists. A compound about 300 times as sweet as sugar, they report, has been created from the waste material. If tests prove it harmless to the human system, it may become widely used for sweetening foods, especially for diabetic patients.

Other compounds may possibly be used for maple or walnut flavoring, or as an added flavoring for coffee. From the corncobs the chemists have also produced raisin, caraway, and apple flavors, as well as rare perfumes, one resembling champaca, a heavy, fragrant odor of the flowers of an East Indian tree.

Still another product of these laboratory workers is a local anæsthetic, prepared from cobs, which is said to be approximately as effective as novocaine.

Curious "Log House" Built of Drainpipes

The house with drainpipe walls. Left: Corner of dwelling, showing "log cabin" method of joining.

A "LOG house," in which the "logs" are formed by common red drainpipe tile, has been built in Kingsville, Ontario, Canada. Charles Miner, who erected the unique dwelling, chose tile for the material because it provides dead-air space in the walls to protect the interior from cold in winter and heat in summer.

The house stands on a foundation of cement blocks, except for the porch and steps, which are supported by the tiles. A wooden framework, sheathed with boards in the usual manner, was first erected and the tile "logs" were laid in courses like brick veneer up the sides. At corners, the ends of the tiles overlap in criss-cross fashion, much as did logs in the cabins of pioneer days. Where the ends of the tiles are exposed, they are closed with cement colored to match. This insures dead-air space and prevents birds and squirrels from entering.

The cost of the unusual house is said to have been moderate as compared with the cost of constructing a conventional type wood or brick home.

Trees Worth Millions

WHAT is a tree worth? In answer to that question, Dr. Ephraim P. Felt, former New York State entomologist, reports that fifty fair-sized elms were sold recently at $5,000 apiece and that many trees are worth $10,000. He estimates that the trees of Greenwich, Connecticut, for which the town is noted, are worth at least one fourth the assessed value of the town. This would place the total value of the trees at approximately $25,000,000.

Do You Know a "Decibel?" It's a New Unit

WHEN you hear someone speaking of a "decibel," it is not a man with a cold in his head talking about a decimal. It is a telephone engineer using the latest addition to the list of scientific units.

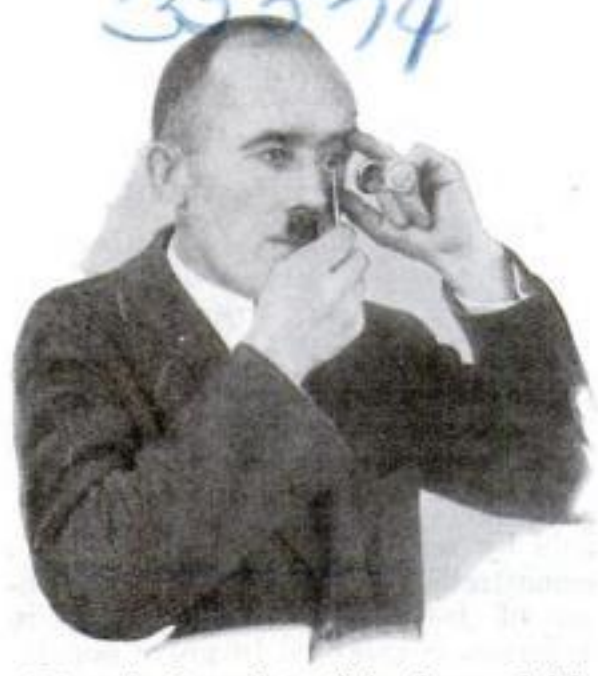
At a recent conference between representatives of the Bell System and the International Advisory Committee on Long Distance Telephony in Europe, the new term, referring to the efficiency of telephone circuits, was adopted. It takes the place of the former expression "transmission unit."

The original unit name decided upon was "bel," named in honor of Alexander Graham Bell, inventor of the telephone. Because the "bel" is larger than is needed in practice, a unit one tenth as large, called a decibel, was accepted for practical use by the engineers.

Helps You Pick a Cinder Out of Your Eye

A SAFETY-FIRST device, small enough to carry in a vest pocket, has been invented by A. F. Ouellet, of New York City, to aid in removing cinders or dust particles from your eyes. A five-power magnifying mirror, one inch in diameter, is fitted with a wire clamp by which it is attached to the little finger of the left hand. While the mirror is held before the irritated eye, the thumb and forefinger of the same hand push back the eyelids, and a folded piece of soft paper, cut to a point, is manipulated by the right hand to remove the dust speck. The eye that is being treated observes the action.

Besides magnifying the eye, the mirror reflects light on the spot where the irritating particle is located. The mirror and clamp fit into a small case for carrying in a man's pocket or in a woman's hand bag.



Mirror is clamped to little finger of left hand while the right hand fishes for cinder.

A Pattern of Progress

EACH month scores of achievements in many fields of research and invention go to make up the variegated pattern of scientific progress. POPULAR SCIENCE MONTHLY reports the news of these achievements in understandable stories and pictures. In these pages you will find a wealth of fascinating new facts to widen your knowledge, ingenious ideas that can be put to use, and entertaining glimpses that will keep you in touch with what other men are doing.

Dual Control for Piano Stops Pupil's Mistakes

PLEASANT news for sensitive-eared parents, to whom the hours when the teacher comes and tries to teach Junior and Mary to coax music from a piano mean sheer agony, emanated the other day from Germany. There an inventor has perfected a device whereby the music teacher may correct the piano pupil's mistakes even before they happen!

The contrivance consists principally of a keyboard like that of a piano. Through electrical impulses sent by way of connecting wires, the teacher can control the interior workings of his pupil's piano from his silent keyboard.

The invention is an adaptation of the principle of dual controls used to instruct students of aviation.

Lights Rout Two Enemies of Fruits and Plants

HANGING festoons of electric lights on apple trees, as is done on Christmas trees, is an effective way of keeping aphids, or plant lice, out of orchards, Prof. A. Franklin Shull, of the University of Michigan, reported recently. Some of the aphids grow wings and fly away from the trees on which they are born; others are wingless and remain to destroy the budding fruit. Dr. Shull discovered that the wingless aphids have not been exposed to sufficient light, but will grow wings if properly illuminated.

The tobacco farmer's most dreaded pest, "mosaic disease," which ruins the leaf for market by forming a mosaic pattern upon it, can be killed by less than fifteen seconds' exposure to ultra-violet rays from a quartz mercury vapor arc, Dr. John M. Archer, of Boyce Thompson Institute for Plant Research, says.

Produces Shapely Pickles

STREAMLINED pickles that will appeal to the eye as well as the appetite are being sought, according to a recent announcement of the Pickle Packers Association. Professor George E. Starr, of the University of Michigan, has spent five years experimenting with cucumbers to evolve new shapes that would combine beauty and edibility, the report states.

The result is said to answer both requirements, and the latest model of pickles will soon be put on the market.

Amateur Carpenters Build Church in a Day

A group of Milwaukee preacher-carpenters trying their skill with saws, levels, and hammers.

Can he hit it? Rev. Thomas B. Lyter, Milwaukee pastor, starting a nail in the construction of a wall section of the church.

Left: The building nearing completion toward the end of the day's work. It even had a first coat of paint.

PREACHERS turned carpenters and churchgoers became builders recently in Milwaukee, Wis., when the new Roosevelt Drive Presbyterian Church was erected in one day. Operations began at eight o'clock in the morning and by five that afternoon the building was complete, with electric wiring installed, chimneys and foundation solidly in position, and with even a small tower rising above the roof of the structure. Painting and decorating the church was practically finished before dark.

All Presbyterian ministers in the Wisconsin city were drafted to help with the construction. Shortly before eight they began appearing, with members of their congregations, carrying saws and hammers. They wore a wide variety of garb, ranging from well-pressed black overcoats and kid gloves to sweaters and workman's mittens. To withstand the cold wind blowing from Lake Michigan, one minister appeared with heavy laced boots, a leather jacket, and an aviator's helmet.

Forty minutes after work began, the skeleton of the structure was up and the wall boards began to go in place. Before noon, part of the roof was on and painters were giving the exterior its first coat of paint, electricians were laying cables, and plumbers were installing pipes.

A building contractor, who is a member of one of the churches, bossed the job and saw that the joists and beams went in the right place and that the scaffolds were strong enough to hold the workers.

Cave Children Had Rickets

BABY dinosaurs and children of cave men had the rickets, just as children of today who have insufficient sunlight and improper diet are afflicted with the disease. Dr. John Foote, Professor of Children's Diseases at Georgetown University, Washington, D. C., states this after a study of prehistoric paintings and the remains of extinct races and animals. Egyptian mummies, as well as the bones of early American Indians, show the effect of rickets, he says, and often in primitive religious paintings, the artists unconsciously depicted the effects of the disease.

Parlor Baseball Played with Tiddledywinks

YOU can make "hits," "runs," and "fouls," with a new table baseball game based on the old pastime of "tiddledywinks." A diamond, laid out on a board about two square feet in area, is divided into zones. Small celluloid disks representing batted balls are snapped with a larger disk from home plate. They score "base hits," "home runs" or "fouls," according to the zones in which they land. A player is "out" when a disk comes to rest within or touching the line indicating any fielder's position.

Each player has nine small disks, representing the members of a baseball team. He "bats" until he has three outs, and the one who has the highest score at the end of nine innings of play is the winner.

Skill in snapping the tiddledywink "ball players" into desired zones of the field decides the winner of the novel game.

Finds Tracing Cloth Acts Like "Health Glass"

DISCOVERY of a cheap way of getting ultra-violet rays, which will allow everyone to take sun baths in his own home, is claimed by C. H. Young, of McGill University, Montreal, Canada. Ordinary tracing cloth, such as is used by draftsmen, admits the beneficial rays which are stopped by paper and ordinary cloth, he reports.

Besides allowing the health rays to pass, the tracing cloth filters off other rays, reducing much of the heat, Young discovered. A single thickness of tracing cloth between wide-meshed wire screens will form a curtain that will allow the ultra-violet light to enter the room, at the same time eliminating much of the heat of the sun, as well as glare. While sitting before such a curtain, however, the eyes should be protected by smoked goggles in the same manner as during treatments with so-called "health lamps."

682,308 Bird Immigrants

A THOUSAND canaries a day came to the United States last year, says a report of the U. S. Department of Agriculture. This average is the highest yet attained. Of the 682,308 feathered immigrants of 1928, half a million were these cheerful yellow song birds. Parrots ranked next, numbering 56,307. They came chiefly from Australia and tropical America. As very few parrots breed in captivity in the United States, their number must be constantly replenished.

Of the game birds imported, nearly two thirds were Mexican quail.

Hitching Phonograph to Radio

How to Connect an Electrical Pick-Up That Will Switch You from Broadcast to Recorded Programs, as You Please

By ALFRED P. LANE

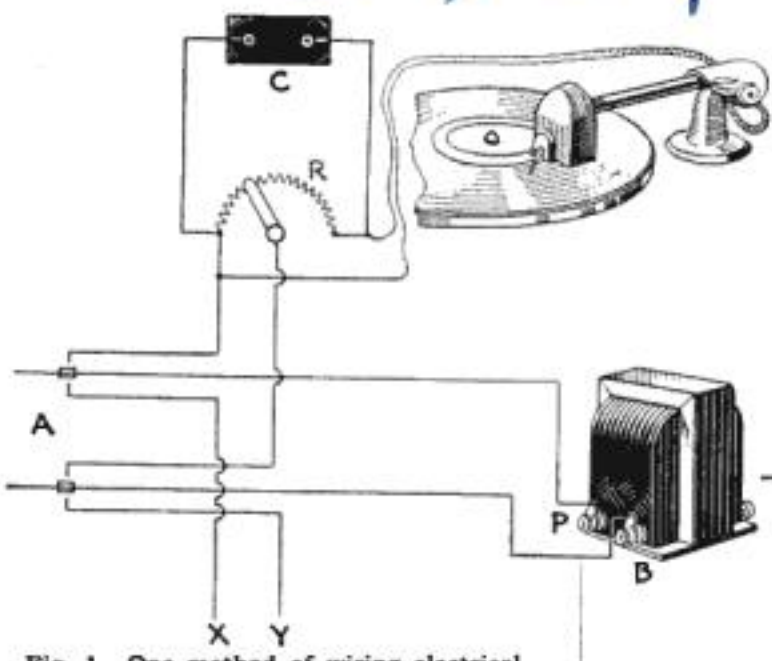


Fig. 1. One method of wiring electrical pick-up to audio amplifier of radio receiver.

NO MATTER how you twirl the dials on your radio set, you often find that you can't get dance music just when your guests feel in the mood for dancing. And at other times, when you want soothing music, the air frequently seems filled with an uninteresting hash of jazz and thinly disguised advertising.

Furthermore, there are times, particularly during the summer, when the static is so bad that it spoils radio reception except, perhaps, from the nearest local station.

However, there is an easy and simple way to get the kind of music you want when you want it. An electrical pick-up and a phonograph turntable operated in connection with your radio receiver will enable you to listen to radio programs when they please you, and the rest of the time to manufacture your own musical program from a selection of phonograph records.

Most radio fans know in a general way how the radio impulses conveyed to the radio receiver by the antenna result in understandable sounds coming from the loudspeaker. The process is almost unbelievably intricate if you dig down into the real scientific whys and wherefores. But you don't have to master all these scientific details to obtain an adequate understanding of the electrical phonograph pick-up.

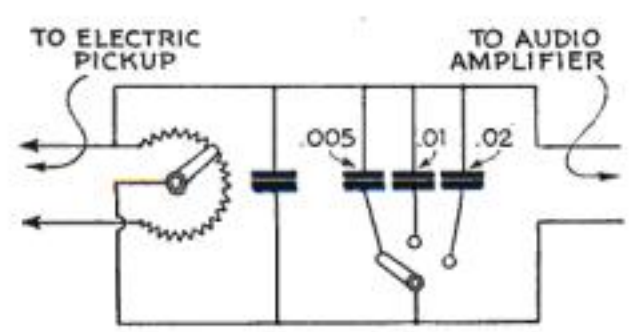


Fig. 2. Control system for eliminating needle scratch, giving a choice of three condensers.

THIS article shows you how to use either the audio amplifier in your radio receiver or a separate high-power amplifier to reproduce modern phonograph records. You should have no trouble following the directions for connecting an electrical pick-up. However, if your own case presents special problems or difficulties, explain your troubles in detail, preferably with diagrams, in a letter to the Technical Editor, POPULAR SCIENCE MONTHLY.

The radio signal reaching your antenna is a high-frequency electrical oscillation. In other words, the current is traveling first in one direction and then the other and changes direction between 550,000 and 1,500,000 times a second, depending on what station you are receiving. As the human ear cannot hear a sound vibration much beyond 30,000 waves a second, you could not hear the radio wave even if it were converted into an air vibration. Moreover, the radio impulse is extremely weak, so three things must be done to it before you can hear it. One is to make it much stronger. Another is to convert it into a frequency that will register on the human ear. And then, when that has been accomplished, the sound wave must be multiplied many times in order to attain loudspeaker strength.

The first of these jobs is performed by the tubes marked "RF" or "Radio Frequency" in your receiver. The second is done by the detector tube. Then the audible signal coming from the detector tube is raised to loudspeaker strength by the audio amplifier stages in your set.

Most everybody knows how an ordinary phonograph works. The needle follows the wavy groove in the record and makes the diaphragm of the sound box vibrate in time with the waves in the groove. The diaphragm transmits its vibrations to the air and these vibrations reach your ear by way of the horn. Thus the phonograph converts the vibrations produced in the needle directly into sound waves by mechanical means. In the electrical phonograph pick-up the needle vibrations are converted into equivalent electrical vibrations. These are amplified through the audio amplifying stages of your radio receiver and reproduced as sound through the radio loudspeaker.

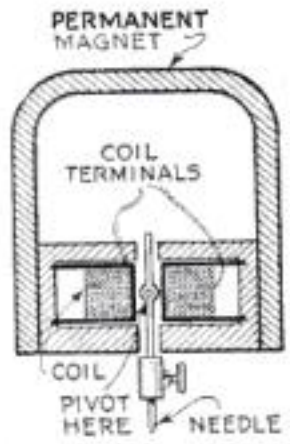


Fig. 3. Construction of a typical balanced armature type pick-up.

Figure 3 is a diagrammatic representation of a typical balanced armature type of electrical phonograph pick-up. A strong permanent magnet is fitted with double pole pieces, between which is mounted a coil of fine wire. The armature of iron is pivoted between these pole pieces. A socket and a set screw for a regular phonograph needle is provided in one end of the armature. Usually the space between the armature and the pole pieces is packed with live rubber to prevent unwanted motion.

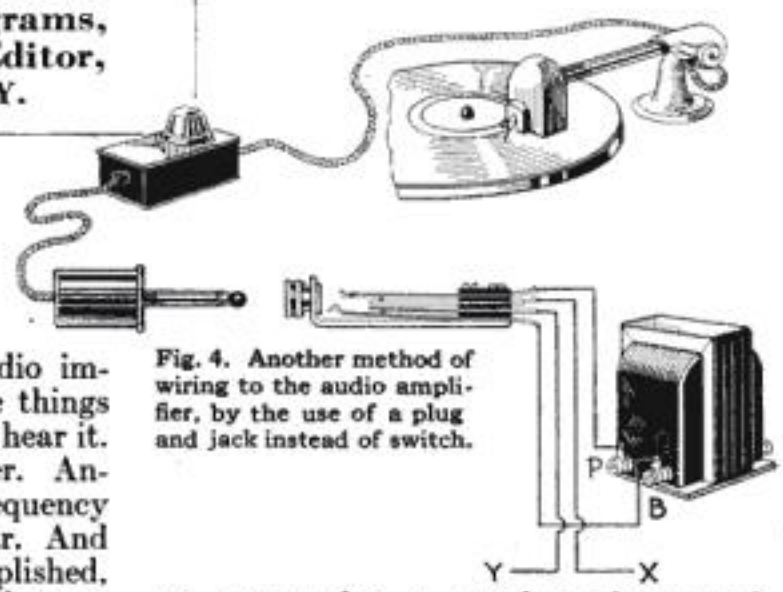


Fig. 4. Another method of wiring to the audio amplifier, by the use of a plug and jack instead of switch.

That's all there is to it, and its operation is equally simple. As the needle moves back and forth in following the wavy groove in the phonograph record, it changes the strength of the magnetic field between the pole pieces and consequently changes the field in which the coil is located. These changes in the magnetic field generate in the windings

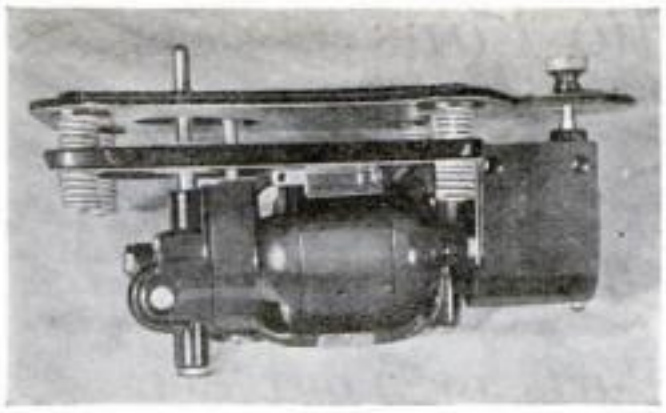


Fig. 5. Mounting of electric drive turntable. The turntable itself is omitted to show the motor.

corresponding electric currents. These currents are strong enough to give satisfactory reproduction of the phonograph record in a pair of ordinary headphones attached directly to the winding in the electrical pick-up. The volume is roughly equivalent to the strength of signal you get out of headphones hooked in the detector circuit of a radio receiver.

Now, to obtain loudspeaker volume, the process is exactly the same as in amplifying the signal from the detector tube in the radio set. An audio amplifier is needed in either case. Your radio receiver contains such an amplifier. Figs. 1 and 4 show two ways to do a permanent wiring job that will permit you to use the audio amplifier in your radio receiver to amplify the output of an electrical pick-up. Both methods allow you to shift instantly from radio reproduction to phonograph music and vice versa, simply by throwing a switch or pulling a plug, and without disturbing the tubes in the radio receiver.

THE switch *A* in Fig. 1 may be either a plain, porcelain base, double-pole, double-throw battery switch, or a panel-mounting jack switch of the same type. The audio transformer shown at the right represents the first stage audio transformer in your radio receiver. If the terminals of the transformer in your set are not marked, you can identify the P terminal by checking the wiring. The P terminal of the transformer always is connected to the P terminal of the detector socket either directly, through the tickler coil, or by way of a radio-frequency choke coil.

The wires *X* and *Y* are the wires which, in your receiver, were attached to the P and B binding posts of the audio transformer, the *X* wire going to the P terminal and the *Y* wire to the B terminal. Fig. 4 is essentially the same except that a double-circuit jack is used instead of a double-pole, double-throw switch.

IN FIG. 1, when the switch *A* is thrown to the up position, the electrical phonograph pick-up is connected to the primary winding of the first stage audio transformer. In the down position, the circuit is restored to its original condition so that the weak audio signals from the detector tube are applied to the winding of the transformer. In Fig. 4, when the plug to which the electrical pick-up is attached is inserted in the jack, the pick-up is connected to the transformer and when the plug is withdrawn, the circuit is restored for radio reception.

The volume control, when you are reproducing phonograph records electrically, usually is accomplished by the aid of a potentiometer such as *R* in Fig. 1. The value of this potentiometer may be anywhere from 10,000 to 50,000 ohms. The potentiometer *R* and a fixed condenser *C* usually are mounted in the control box that is part of the complete electrical pick-up equipment as supplied by the dealer. The function of the condenser is to by-pass the very high frequencies and thus greatly reduce the scratching noise produced by the needle. Some of the higher overtones of the music are reduced thereby, but the net result is improved. If you want to arrange to cut even more of the needle scratch you can wire a control system as shown in Fig. 2, where the fixed condenser supplied with the outfit is supplemented by any one of three additional condensers at the choice of the operator.

Fig. 6. Complete assembly of powerful audio amplifier, radio receiver, electric turntable, and electrical phonograph pick-up.

One of the features of home assembled radio and phonographic reproducing apparatus is the wide latitude possible in fitting the equipment into existing cabinets or other available space.

Fig. 6 shows one method of assembling a powerful audio amplifier, a radio receiver, an electric turntable, and an electric pick-up in a cabinet ordinarily designed to house a battery set, the batteries, and a built-in horn loudspeaker.

In the lower compartment is installed the super-power audio amplifier described in detail in the March number of POPULAR SCIENCE MONTHLY. In the middle compartment is a radio receiver consisting only of the radio-frequency amplifier and detector circuits. The top compartment is fitted with a separate pair of inner doors. The phonograph unit is installed between partitions in the center of the compartment, leaving space in side compartments to accommodate several phonograph record albums.

The use of an electric drive turntable has nothing to do with the electrical reproduction of the phonograph records. The pick-up will work just as well if the turntable is turned by the power of a spring wound by hand, so if you have an old phonograph, you can, of course, mount the pick-up in place of the old tone arm and use an extension cord to reach the cabinet where the audio amplifier is housed. Similarly, you can mount the electric drive turntable and the pick-up in some other cabinet or even in a convenient bookcase if the radio cabinet is not large enough to include it.

THE mounting of an electric drive turntable such as is shown in Fig. 5 is very simple. In this view the turntable itself was left off to show the motor more clearly. The turntable fits over the center pin and is driven by friction so that there will be no chance of stripping the fully inclosed worm gearing. A special type of motor that has no brushes is used, so that it cannot create electrical interference. It operates, of course, on the 110-volt A.C. supply from the light wires.

The mounting consists simply of an open box turned upside down with an opening cut in the bottom, into which the motor drive can be set. The outside measurements of the box are five by twelve and a half by fifteen inches. A control panel is fitted to one side and holds switches to control the change from radio to phonograph, to start and stop the phonograph table motor, and to control the volume.

The high-grade dynamic speaker mounted on a baffle board, which was described in the April number of POPULAR SCIENCE MONTHLY, is ideal for use with such an outfit.

THE jack switch *A* shown in Fig. 1 is at the extreme right on the panel of the phonograph unit pictured in Fig. 7. The P and B wires go to the binding posts on the super-power amplifier marked "Input," the Y wire goes to the 0 to 90 volt binding post, and the X wire connects with the P terminal of the detector tube socket in the radio receiver.

The knob on the panel in Fig. 7 controls phonograph volume. Wiring is shown in Fig. 1. The switch at the extreme left of the panel in Fig. 7 is a single-pole double-throw switch that turns off the filament-heating transformer in the radio receiver and turns on the current to the phonograph motor when you wish to play records. The remaining switch is wired into the phonograph motor circuit to stop it while you change records.

Fig. 7. The electric turntable on its simple mounting, showing control panel with switches.

Useful Hints for the Radio Fans

Trouble-Shooting with Phones

How to Test Transformers or Other Parts of Your Set with a C-Battery and "Earmuffs"—Tips on Regeneration

WITH a pair of headphones and a dry cell C-battery, you can track down many of the troubles you may have with your radio receiving equipment. Of course an ordinary doorbell battery would serve just as well, but the C-battery is handy because it is small.

And if you know how to use them, the headphones alone will locate many troubles or at least determine the section of the receiver that requires attention.

In your receiver, the electric currents travel in definite paths. When a break occurs in one of these paths reception stops or is greatly impaired. Complete stoppage follows any break in the filament wiring, but a break in any of the high-frequency circuits may not absolutely stop the signals from getting through. High-frequency currents are able to jump breaks, to some extent, by way of the electrical capacity of the adjacent wires.

Suppose, for instance, that you can find nothing wrong with any connections, yet the set is dead, with no sound from the loudspeaker. Connect the headphone cord tips in place of the P and B terminals of the first audio transformer. If you hear the broadcasting you may be sure that whatever trouble exists is in the audio amplifier end of the set and not in the radio-frequency or detector stages. Shift the cord tips to take the place of the P and B terminals of the second audio transformer. If the signals are heard much louder, you can forget about the first audio stage and concentrate on finding out what's wrong with the last audio stage.

Then, if one of the audio transformers is suspected, just hook one phone cord tip to a terminal on the C-battery, connect the other terminal of the battery to one primary terminal of the audio transformer, and touch the remaining cord tip to the other primary terminal of the transformer. If you hear a good, snappy click when the contact is made and another when it is broken, you can be sure nothing is the matter with the winding. After that you can test the secondary winding in the same manner.

If the click is extremely faint or inaudible the wire of the winding is broken at some point.

RADIO-frequency choke coils, tuning coils, resistances—even grid leaks—can be tested in the same way. If you suspect that the plates of a variable condenser are touching at some point on the dial, you can connect condenser in series with the headphones and the C-battery and turn the rotary plates. If the latter touch

Testing audio transformer. A sharp click in phones says the windings are all right.

the stationary plates at any point there will be a tremendous clatter in the headphones.

To find out if a fixed condenser is short-circuited, connect the cord tips to the terminals of the condenser and connect one terminal of the battery to one terminal of the condenser. Then snap a wire from the other terminal of the battery across the other terminal of the condenser. If the condenser is completely short-circuited, there will be practically no click in the phones.

A B C's of Radio

THE grid in a radio vacuum tube is the electrode that controls the tube's action. The electron flow from the heated filament must pass through the grid to reach the plate and thus cause current to flow in the plate circuit.

In a radio-frequency amplifier circuit the grid is connected to the radio-frequency transformer, and in an audio-frequency amplifying circuit to one end of the secondary winding of the audio transformer. In either case the voltage developed in the transformer is applied to the grid. The changing voltage of the grid causes a corresponding change in the flow of the electrons and consequently in the plate current which actuates the transformer of the next stage following, or the loudspeaker in the case of the last tube.

Regeneration and Quality

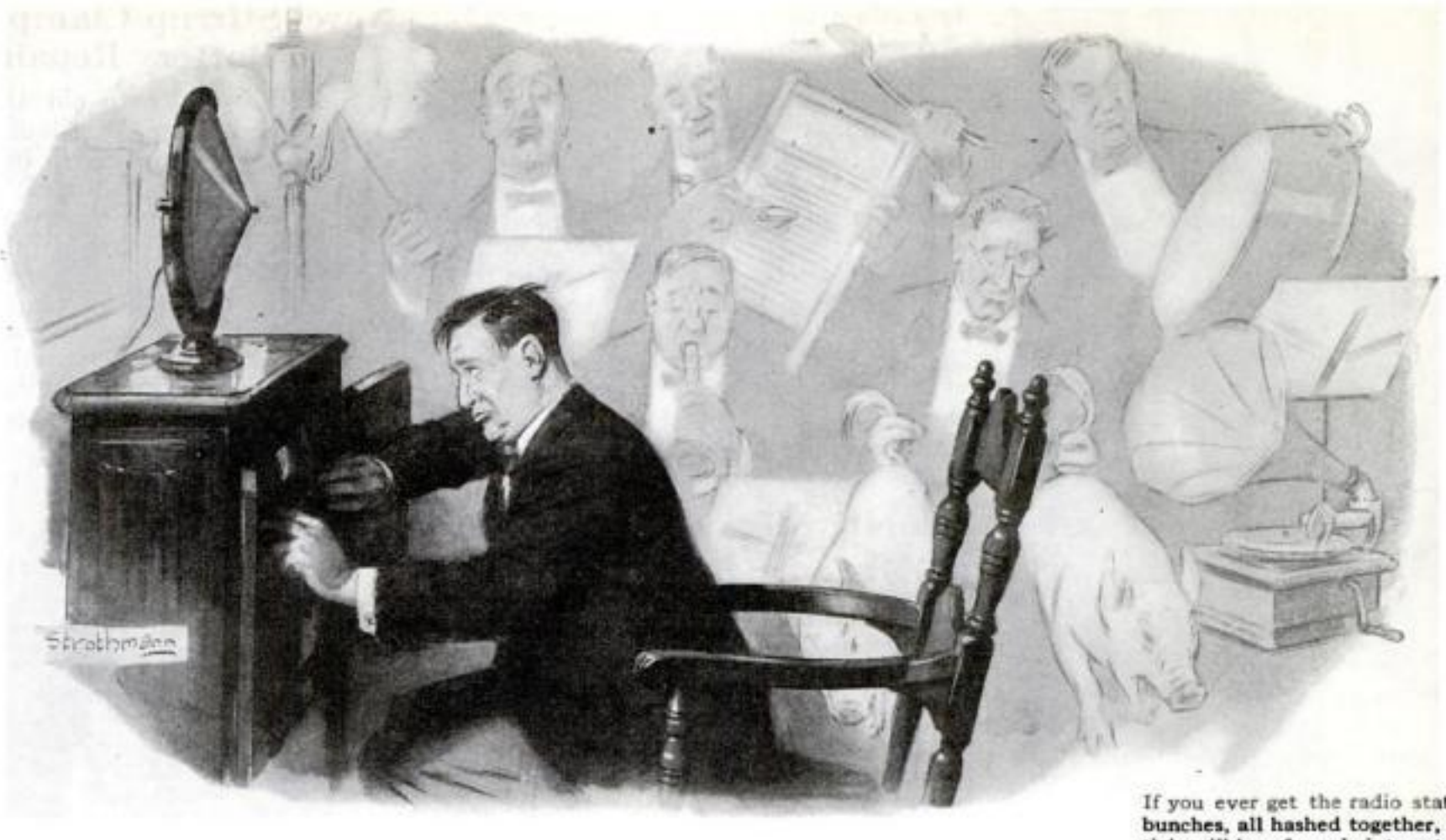
RADIO receivers vary considerably as to their sensitiveness at different wave lengths. Many are extremely sensitive on the lower end of the broadcast band and much less sensitive when tuned to any wave in the upper portion of the band. That is why static usually seems much worse on the low waves. The static really is no worse in most cases. It merely sounds louder because the set is more sensitive at that point. This also accounts for the fact that you often can get a relatively low-powered station near the lower numbers on the dial with good volume when a much more powerful station tuning-in near the other end of the dial cannot be heard at all.

Sometimes the condition is reversed in sets using the grid resistance method of suppressing oscillation, because the effect of the grid resistances is much greater on the low waves. In any set, maximum sensitiveness and selectivity will be obtained when the radio-frequency stages are on the verge of oscillation. Unfortunately, however, tone quality always suffers when oscillation, otherwise known as regeneration, is excessive.

In designing a radio receiver, the engineer always strives to have just enough regeneration in the circuit to give best results without unduly affecting tone quality. And if he can accomplish this result with not too great a difference in sensitiveness at various points on the dial, the receiver will be a success—assuming, of course, that it is fitted with an audio amplifier that gives the desired volume without distortion.

The Right Grid Leak

NO TWO vacuum tubes require exactly the same value of grid leak for maximum results, but in any case the higher the resistance of the grid leak the greater will be the sensitiveness of the tube to weak or distant signals and the greater will be the tendency toward distortion on the local stations. The rule, therefore, is to use a grid leak of from two to five megohms when you are hunting distant stations, and a leak of as low as one half megohm if you are principally interested in obtaining the best possible tone quality.



If you ever get the radio stations in bunches, all hashed together, this article will be of much interest to you.

Unscrambling the Radio Hash

When "Squealing Pigs" Get Mixed with "Dishpans" and Sour Sopranos, Don't Blame Your Set — Tell It to Uncle Sam

By JOHN CARR

"LAST night," one of my neighbors told me, "I took a notion to do a little radio exploring and what do you think I dragged in?"

I smiled in anticipation, for this man is good at stringing the long bow. "Now you're going to tell me," I countered, "that you got Japan or Australia."

"Oh, no. Nothing like that," he said. "I wasn't spraining my set trying to get real distance. Just didn't like the local programs so I set out to find a station with something different. And I got lots of 'em. Only trouble was that most of the stations sounded as if they were broadcasting bands made up of tinny old phonographs, somebody slugging a dishpan, squealing pigs, and steam whistles for variety. The rest were spouting sour sopranos. Near the bottom of the dial I got 'em in bunches like bananas, but all hashed together. What in blue blazes is the matter with my set?"

My neighbor's experience is not unique. Those of you who have ventured out of the beaten radio paths leading to local stations have had similar difficulties.

But before you go gunning for the dealer who sold you the set, look at a complete list of the stations now broadcasting in the United States. There are hundreds, yet competent radio engineers agree that only about ninety-five stations can be crowded into the broadcast band without possibility of interference.

Some of the larger and more popular stations operate on what are called "cleared" channels. Each has a wave for its exclusive use. Theoretically, at least, you should receive such stations without interference. Actually that is not always the case. Reception from WJZ in New York, for instance, often is marred by a high-pitched whistle caused by heterodyning with the wave from some other station off its own wave or so heavily modulated that it slops over outside its own band.

Don't blame your set for whistles of this nature. You couldn't get rid of them with any set. However, reception such as my neighbor reported is found on the lower portion of the wave band where many relatively low power stations in different parts of the country operate at the same time on the same wave. In theory, the range of these small stations is so limited that they cannot interfere. But on any night favorable for transmission, any one of them may shoot its carrier wave thousands of miles and mess up the reception from other stations on the same wave. Here, too, your set isn't to blame, nor is there anything you can do about it except to tune away from the interfering stations.

Like many others, you have been led to believe, perhaps, that the new rearrangement of stations would end all interference; and you have reasoned, quite logically, that any interference necessarily must be the fault of your set. Perhaps some day the Federal Radio Commission will get things straightened out so you won't get two stations at once on any wave. The Commission has a difficult problem to solve, and you can help it by making reports of all interference between stations. Simply give the technical facts such as the time of day, the call letters of the stations involved, the presence or absence of steady whistling noises, the length of your antenna, and the type of receiver.

Fortunately, enough stations are operating on cleared channels to assure that you can get at least one without interference. In favorable localities you may have a half dozen to choose from.

REMEMBER, too, that while your own receiver may not be as selective as it might be, any material increase in selectivity would result in poorer tone quality. This is because an ultra-selective set almost invariably chops the side bands from the radio wave you are receiving. The side bands carry the higher audible frequencies. When they are lost the announcer's voice becomes throaty and difficult to understand and the lost overtones spoil the music.

However, radio reception costs but a few cents an hour at most. When we remember that for this trifling sum we can listen to the world's finest singers, the most famous orchestras, word by word reports of important sporting events, and a host of other good things, there seems small ground for kicking at slight inconveniences.

Drawing Water Power from Scotch Highlands

PLUNGING 600 feet down a mountainside through three huge pipe lines, tons of water from a highland lake in central Scotland will crash against the turbine wheels of an electric power plant now nearing completion in the valley below.

The major link in this great water power project is a fifteen-foot tunnel bored for fifteen miles through the mountain, Ben Nevis. When the water reaches the lower end of this tunnel, it enters three pipe lines, each measuring five feet nine inches in diameter, for the drop to the power plant.

The project, said to be the largest ever attempted in Scotland, is designed to supply electric current for a British aluminum company which is building a large factory at Fort Williams, a village near Ben Nevis. The photograph above, showing two of the huge pipes, gives an idea of the precipitous drop.

Designs Great Telescope Mirror Like Honeycomb

EGGSHELLS, spider webs, and honeycombs were studied by Prof. George W. Ritchey, famous astronomer and designer of the 100-inch Hooker telescope at Mt. Wilson Observatory, California, in planning a new instrument unlike any telescope ever built before. These everyday objects were examined to compare the details of their cellular construction.

His plan is to build a monster reflector, as large or larger than the 200-inch one planned by the California Institute of Technology, of pieces joined together like the cells of a honeycomb. This unique method of construction, Prof. Ritchey believes, will permit the building of telescopes larger than would be possible by casting the mirrors as a single disk.

Another advantage of the "cellular" construction, he points out, is that the small pieces that make up the large mirrors can be transported up narrow trails to mountain observatories where it would be impossible to take the huge, fragile disks of single-piece mirrors. Professor Ritchey is working on the new reflector in this laboratory in Paris, where he was invited by the French after he designed the Hooker telescope several years ago.

A dome of steel, concrete, and cork is contemplated for housing the new instrument. The cost of the telescope and observatory is estimated at from $10,000,000 to $15,000,000.

Fugitive Trapped by Long Distance Radio Photo

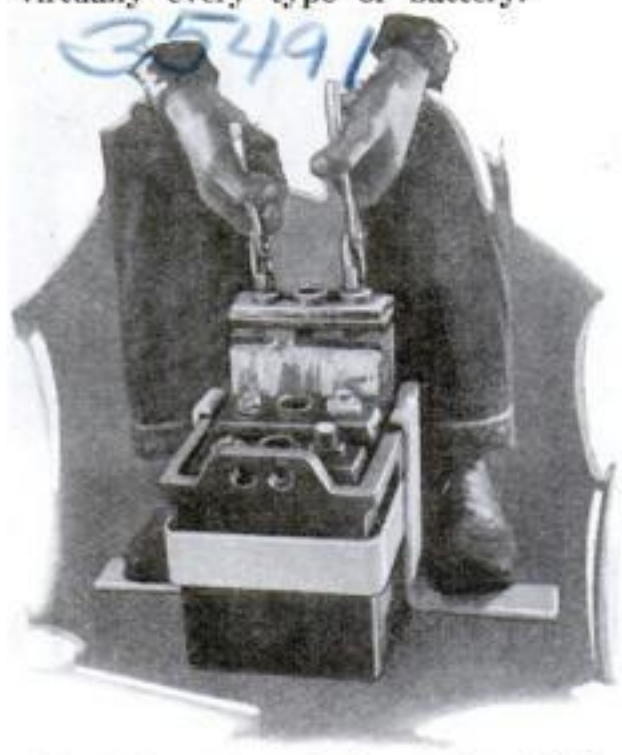
RIDING the ether for 2,600 miles, the radioed photograph of an escaped forgery suspect recently resulted in his identification and arrest in Honolulu when he disembarked from a vessel there after eluding New York detectives who had trailed him across the continent.

After jumping bail in New York, the suspect started for the Orient. He was followed to San Francisco, where the detectives missed him by a day. A radio message to the captain of the vessel resulted in determining that a man resembling the suspect was on board.

Detectives sent his photo by radio to Honolulu, where the man was arrested when the ship docked. The cost of transmitting the picture was fifty dollars.

Novel Stirrup Clamp Aids in Battery Repairs

A SIMPLE device to aid the repair man in removing the cells of a storage battery has been invented by R. W. Grice, a garage proprietor of Taunton, Mass. It is a slip-on clamp which fits around a battery, and is equipped with stirrups upon which the mechanic stands to hold the battery down while he pulls out the cells. In reinsulating a battery, all three cells can be removed at once. The inventor claims the device will fit virtually every type of battery.



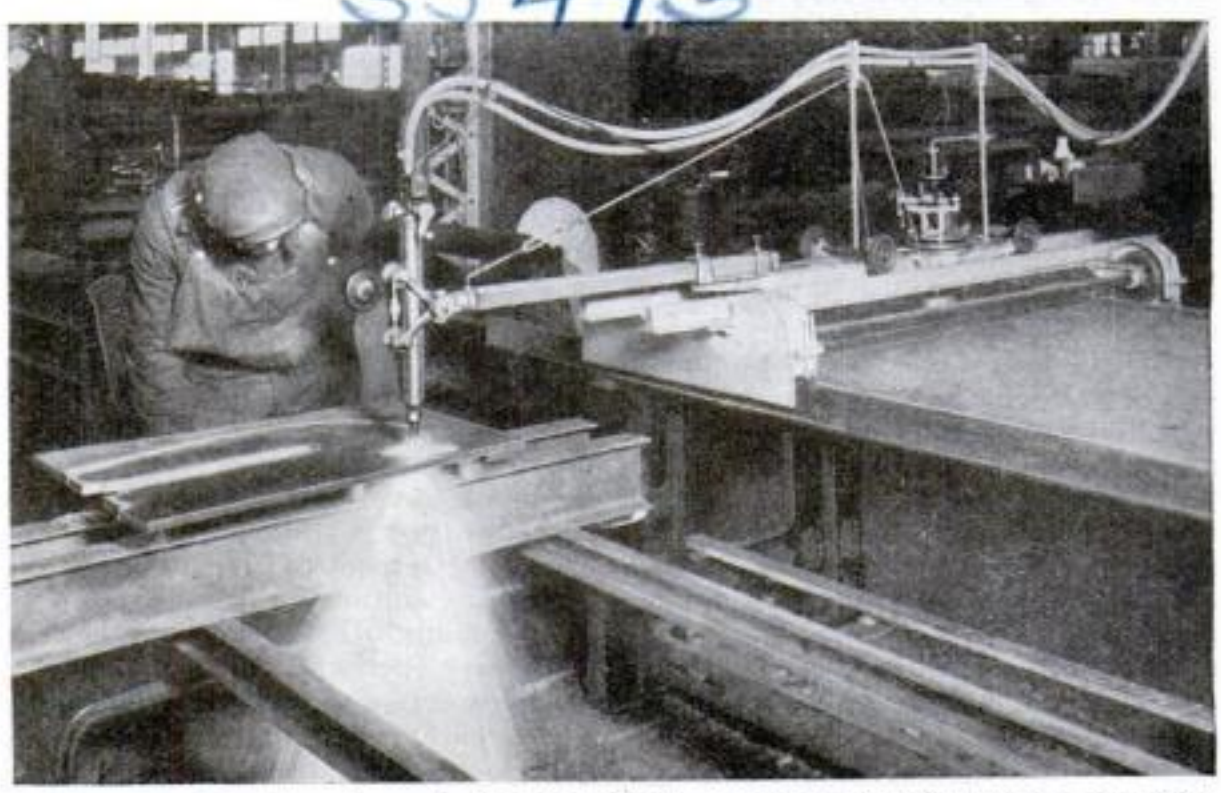
Resting his weight on the stirrups, the mechanic easily lifts out the cells of the storage battery.

Automatic Torch Cuts Steel Like a Jig Saw

A NEW oxy-acetylene shape-cutting machine has been invented to cut intricate patterns out of heavy steel sheets, plates, and ingots almost as easily as shaping wood with a jig saw. The cutting torch is mounted on a carriage which is moved in any direction by means of an electric motor. For quantity production, it is claimed the machine can be set to operate automatically. For special work, a special tracing device is attached which enables the operator to direct the torch along intricate lines and curves of a pattern laid out on the steel.

The speed of the cutting is from three to twenty inches a minute, according to the thickness of the metal. Tests are said to have shown that the melting heat of the torch will cut through material a foot or more in thickness, producing straight corners and smooth faces that require little machining.

Rigid construction of the machine's parts is combined with the delicacy of adjustment which is necessary for precision. Only one operator is required.



Cutting out a pattern from a heavy sheet of steel with the new oxy-acetylene "jig-saw" machine. The cutting torch is mounted on a carriage which is moved by an electric motor in any direction.

Diet of Milk Makes Worms Alluring to Fishes

IF WORMS are fed on a diet of moss and milk they turn a delicate pink, which increases their value as bait. This process, known as "scouring," was recently described in a report of the U. S. Department of Agriculture by W. R. Walton, said to be a distant relative of the patron saint of all anglers, Izaak Walton.

The worms are placed in a container filled with moss. Sphagnum moss, found in damp woods throughout the northern states, is preferable. Three or four days of the moss diet prepares the worms for use. If they are kept in the container for longer periods, the diet should include sweet milk once a week, and the moss should be washed every ten days.

This unique diet is said to make the worms more lively, tougher, and more easy to handle. The skin becomes transparent. The delicate pink color, for some unknown reason, is alluring to many kinds of fish, especially game fish such as trout, Walton reports.

More Lime, Fewer Divorces, Declares Dietitian

DIVORCES would be fewer if people consumed more lime, Dr. George Walker, dietitian, recently told a national organization of housewives at Baltimore, Md. Lack of lime in the human system, he said, makes women nervous and men cruel, and disrupts family happiness.

Drinking milk is the easiest method to get the needed lime, he declared, and a quart of milk a day and two oranges added to the diet of the average person would improve his temper.

Newest Oil Locomotive Could Light a Town

WITH a single controller, similar to that on an electric street car, and an air brake valve, the engineer governs a new 650,000-pound oil-electric locomotive which the Canadian National Railways soon will put into service.

The locomotive consists of two units, which may be operated separately, if desired. Each contains a pair of oil engines operating generators which supply electric current to drive the wheels. The supply of oil carried—about 8,000 pounds—is sufficient to operate the motors under normal conditions for twelve hours. Each unit also carries 11,000 pounds of boiler water, 3,000 pounds of engine jacket cooling water, 1,000 pounds of lubricating oil, and 3,000 pounds of sand. A motor-driven pump fills the fuel oil tanks.

The electric power generated by the engines would be sufficient to light a good sized town, while the apparatus for heating trains from the locomotive boiler water could heat a modern apartment.

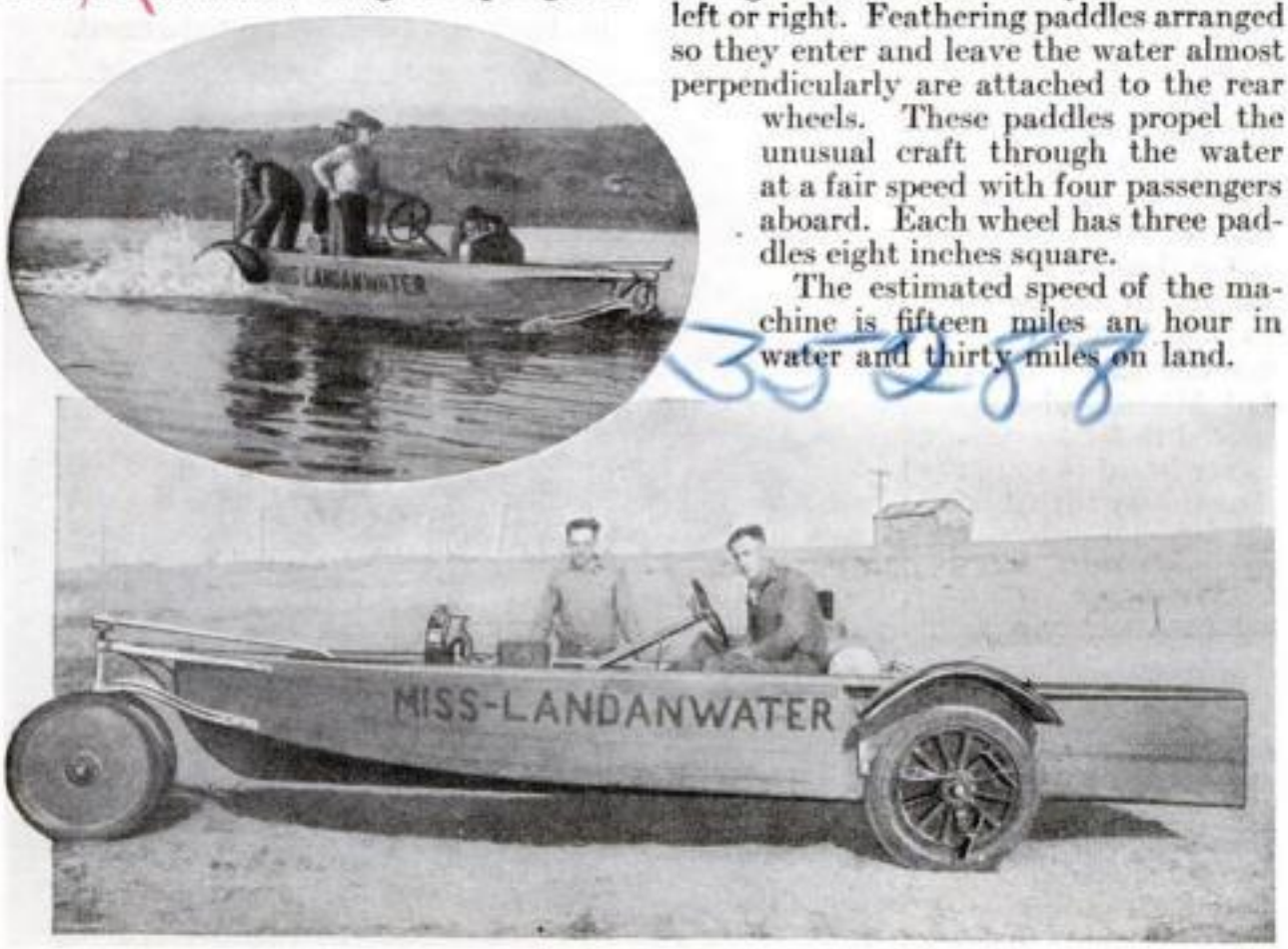
When the first oil-electric locomotive was installed on the Canadian National Railways, in December, 1925, it established what is claimed to be a world record by making a continuous run of 2,937 miles from Montreal, Quebec, to Vancouver, British Columbia. Economies effected by the new type engines are expected to slash operating costs.

Odd "Flivver" Craft Rides on Land or Water

AN AMPHIBIAN "flivver" has been added to the list of land and water boats by Charles Wyborney, of Wilbur, Wash. His unique craft, named *Miss Landanwater*, slung on springs, is said to ride as easily on the road as an ordinary automobile.

The same steering gear is used in the water as on the land, the front disk wheels acting as rudders when they are turned to left or right. Feathering paddles arranged so they enter and leave the water almost perpendicularly are attached to the rear wheels. These paddles propel the unusual craft through the water at a fair speed with four passengers aboard. Each wheel has three paddles eight inches square.

The estimated speed of the machine is fifteen miles an hour in water and thirty miles on land.



The speedy amphibian "flivver" as it appears on water and on land. Paddles on rear wheels drive it in water, and front wheels steer it; thus the vehicle runs from land to water without adjustments.

Trees Fed by Millions of Microscopic Slaves

MILLIONS of microscopic slaves toil up and down in tubes that extend like flues through the bark tissues of every tree, Dr. Otis F. Curtis, of the New York State College of Agriculture, Cornell, has concluded after tests.

Unlike the sap tubes in the woody part of the tree, says Dr. Curtis, the veins in the tissues of the bark region are filled with certain living protoplasm. This protoplasm circulates like an endless belt, moving up one side of the long tubular cells and down the other. The upward stream carries the food salts absorbed from the earth by the roots and the downward stream transports the sugars manufactured by the leaves from the air, so that the tree is completely nourished.

The belief in the past has been that the salts and sugars which fed the tree were carried with the water through the woody part of the trunk.

Demand for Sawdust Fuel Causes a Shortage

A "SAWDUST famine" has occurred in lumber manufacturing towns of the Pacific Northwest. For years the mountains of sawdust, accumulating around the lumber mills, were looked upon as white elephants by the mill owners. Recently there was invented a burner attachment that could be connected with house furnaces, heaters, or mill boilers to allow them to burn the waste product. So many people installed the burners, it is said, that the sawdust mountains disappeared and the cheap fuel had to be brought by motor trucks, scows, and electric interurban trains from mills as far as 200 miles away.

Special mills for grinding waste pieces of lumber into sawdust are now proposed.

Using the new attachment, the business man and his secretary both listen to a telephone conversation over the same receiver.

Carrying sound from the standard receiver through a rubber tube, the device permits the user to listen with both ears, as below.

Two Ears Now Can Listen at One Telephone

A TELEPHONE attachment which permits the user to listen to a long distance call with both ears, and incidentally allows two people to hear from a single receiver at the same time, has been designed especially for noisy offices. The device is a sound-distributing chamber which slips over the end of the standard telephone receiver and sends part of the sound through a rubber tube ending in a metal cup, similar to that on a doctor's stethoscope, which fits in the opposite ear of the user. Thus the person who is telephoning can listen to the conversation undisturbed by outside noises, and has one hand free to make notes, the maker points out.

When it is important for two people to hear a telephone conversation, one may listen through the standard receiver, the other through the rubber tube. The attachment can be slipped on the receiver or removed in an instant.

Larger and Faster Liners to Ply the Atlantic

THE fastest Atlantic steamship crossing of history was made recently when the Cunard liner *Mauretania* reached Plymouth, England, just four days, nineteen hours, and fifty-five minutes after leaving New York. This time is two hours and two minutes faster than the previous record made by the same vessel last year. The average speed of the *Mauretania* was 25.26 knots.

A liner that is expected to clip several hours from this record is to be laid down soon in France. It will have nearly twice the tonnage of the *Mauretania*, will be almost a thousand feet long, and is expected to cross the Atlantic at a speed of twenty-seven knots. The engines of the giant ship will develop forty-five thousand horsepower.

Another thousand-foot ocean vessel is under construction at Belfast, Ireland. It is being built by the White Star Line for service between England and America.

New Red Dye from Cactus

RED neckties of a new shade may result from the discovery by a German chemist, Prof. H. Molisch, that a certain species of cactus can be made to produce a natural plant dye. The new dye has been named "cacto-rubin." It is produced when the cells of the plant die.

Reads Name of Explorer on Mystery Rock

A FLASHLIGHT photograph recently solved the mystery of the strange inscriptions on Dighton Rock, on the Taunton River in Massachusetts, which have led to innumerable wild conjectures in the last 200 years. This rock is exposed by the tides for only brief periods. The worn inscriptions upon it have been attributed at various times to the Phoenicians, the Norsemen, the lost tribes of Israel, the Chinese, the Druids, and even the inhabitants of the traditional lost continent of Atlantis, the theory being one or another of these peoples once visited the eastern coast of America.

Recently Dr. Edmund B. Delabarre, of Brown University, began photographing the mysterious rock by flashlight. A study of the pictures revealed, he reports, that under the inscriptions were the remains of the name "Miguel Cortereal" and the date "1511."

Miguel Cortereal is known to have been one of two Portuguese brothers who sailed to Labrador in 1501. The other brother sailed home but Miguel, who expected to follow, was never heard of again. The theory is that he wandered south and lived with the Indians in Massachusetts for at least ten years. The fact that the picture writing of the strange inscriptions was placed on top of the faded lettering of the name convinces Dr. Delabarre that it must be the product of Indians who lived in the region later than the year 1511.

Cordon of Petunia Vines Guards Against Fires

FLOWER beds are now protecting gas tanks from fire. In California, the experiment has been tried of planting a wide band of petunias around the tanks. It has been found that the trailing stems of these flowers will not ignite when burning matches or cigarette stubs are thrown among them. This prevents small fires from creeping to the tanks and firing their inflammable contents.

In other parts of the state, the same flowers are being planted along the roads near woods to act as a protection against forest fires.

A Cupful of This Poison Could Wipe Out a City

ONE of the deadliest poisons in the world was recently brought from the jungles of South America by Dr. S. H. Williams, of the University of Pittsburgh. Known as "carrere," the liquid is used by savages to poison the death-dealing darts they shoot from blowguns. The jar of poison which Dr. Williams obtained contains no more than a cupful, but he states that amount is powerful enough to kill every inhabitant of a city the size of Pittsburgh. He also brought back with him a number of the fatal darts with their poisoned tips.

Dare-Devil Fireman Dives 85 Feet into Net

A DARING, head-first plunge of eighty-five feet was one of the spectacular stunts exhibited recently by members of the Los Angeles, Calif., Fire Department in the Los Angeles Coliseum. Joe Wynn, dare-devil performer from the rescue squad, crawled to the top of two swaying ladders, braced against each other, while a tiny circle of men on the ground held a fire net beneath him.

At a signal, Wynn dropped head first toward the ground. During his plunge, he somersaulted so he struck the net with his back and bounced up unharmed.

A breath-taking plunge. The camera clicked just as Joe Wynn, Los Angeles fireman, started his 85-foot dive into the rescue net below.

Student cops at pistol practice on the school range, where they learn to shoot fast and straight.

Treed by the bloodhounds. The rookie police officers take turns at playing the fugitive and pursuer.

College Course in Pistols and Bloodhounds

A QUEER college which uses bloodhounds, guns, and motorcycles to teach students is maintained at Trenton, N. J. It trains would-be members of the New Jersey State Police Force, putting them through an intensive three month's course of training. The schedule and discipline of this unique training camp for soldiers of the law is as rigorous as that of an Army camp.

One of the important parts of each day's activity is pistol practice. The men, in squads of twelve, toe a line and, under the supervision of two experienced officers of the force, fire at targets placed at various distances from the line. The uniform that is worn by the men in mild weather includes a pair of heavy-soled basketball shoes which give them surer footing during the strenuous athletic games which are part of the training.

Horsemanship is also practiced. A stable is maintained at the camp and the rookies take their turns dashing up and down the grounds of the training school under the direction of trainers. In advanced classes of the school they learn to make jumps on horseback. Motorcycle riding is another fine art taught at this college for cops. Because members of the state police must be able to repair their machines in case they break down while on duty, a course in motor mechanics is part of the curriculum.

Another interesting phase of the training is practice in handling a pack of bloodhounds. One of the men in training attempts to escape from a companion in charge of a pair of the dogs, after which the men change places and the pursuer becomes the pursued, so that each has his turn in trailing a fugitive with the animals.

This practical training, together with the rigid discipline of the school, are expected to develop one of the most efficient organizations of expert police officers in the world.

The loudspeaking telephone apparatus, including amplifier and horn, with small radio receiver attached.

Making a Telephone Talk Through Loudspeaker

"WILL you speak a little louder please?" That request is unnecessary for users of a new telephone loudspeaker invented by H. O. Rugh, of Chicago, Ill. The installation consists of a horn loudspeaker operating from the telephone receiver through an audio amplifier similar to amplifiers used in radio. The latter is supplied with current from the house lighting circuit and is contained in a small cabinet upon which the telephone instrument rests.

The turn of a knob is said to lift the telephone receiver automatically so the voice of the person at the other end of the wire can be heard through the speaker. When the telephone is not in use, the speaker can be used with a small radio receiver especially designed for the purpose and connected with the amplifier. It is tuned with a dial like any other radio set.

Frogs Can Learn a Simple Problem in Geometry

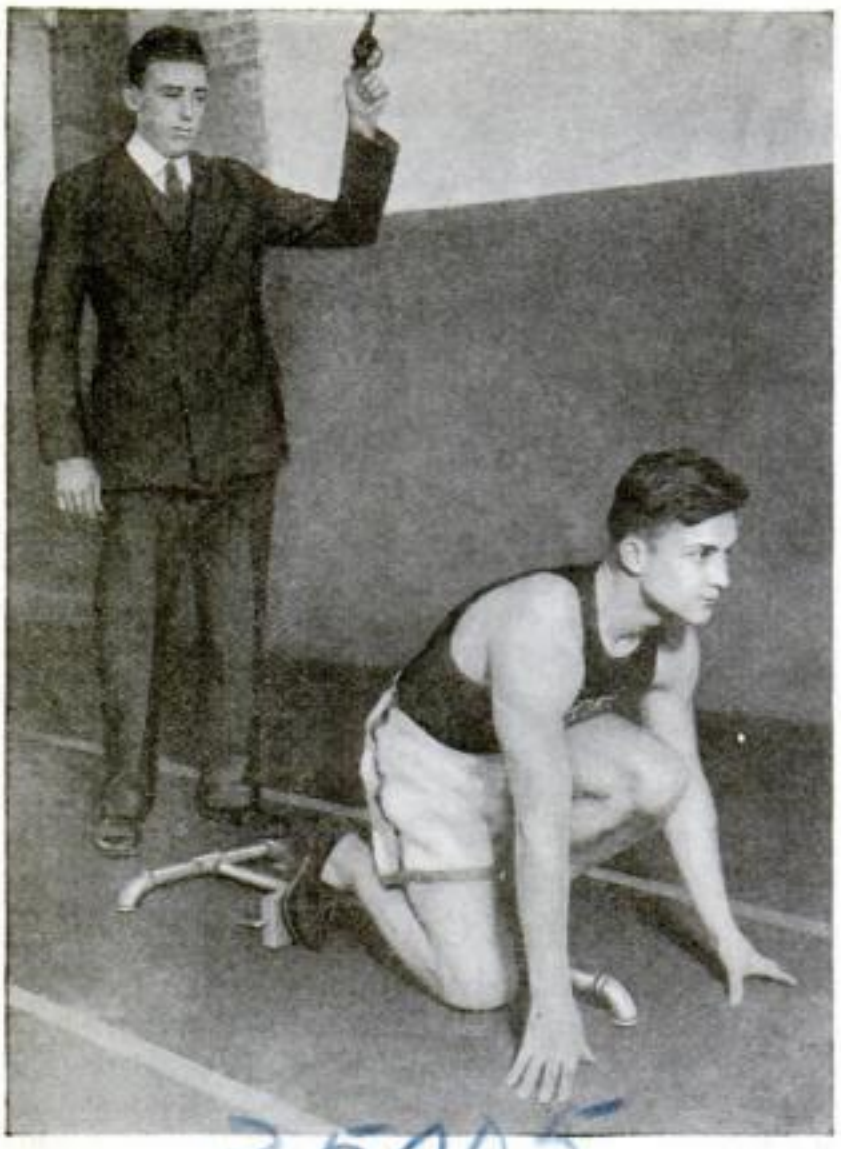
FROGS showed that they could learn a simple proposition in geometry recently when a European experimenter, S. Biedermann, tested them. He found that they could distinguish a square from a triangle. Before the frogs, he set square and triangular blocks in pairs. One of the blocks has an insect attached to it. After the triangular block had appeared accompanied by food for a number of times, the frogs would hop expectantly up to all triangular blocks, ignoring square ones.

Biedermann tested several species of frogs and all showed ability to distinguish between different shaped blocks. He found little frogs were the "brainiest."

Tennis Court 400 Years Old, Still in Use

THE oldest tennis court in the world celebrates its 400th anniversary this year. It is at Hampton Court Palace, in England. Other tennis courts, which date back several centuries, have become merely historic spots, like one at Versailles. But the Hampton court, after providing recreation for the English royal family for four centuries, is still used.

King Henry VIII, in his youth, dashed across the court in many lively contests, as did Charles I, who used to play before breakfast. Shakespeare is said to have visited the court often.



Track Coach Invents New Toe-Hold for Sprinters

DELAYS in track meets, due to the athletes digging holes for footholds at the start of the race, may be eliminated by a new starting device invented by J. P. Nicholson, track coach at Notre Dame University, South Bend, Ind. It consists of a small metal pipe frame, provided with two wooden pedals that are instantly adjustable to the runner's stride when set for the starting pistol.

The frame can be fastened to the ground by stepping upon the crossbar with both feet and thus driving it into the track. In case of a wooden track, the frame has to be held by a person standing upon it. If a sprinter is penalized, the starter can pick up the light frame and place it back in an instant, eliminating the delay occasioned by the digging of new holes.

The photograph shows Coach Nicholson with Jack Elder, champion Notre Dame sprinter, testing the new starting device.

Leaping Car Lands on Another

TWO automobiles figured recently in a spectacular freak accident near Bishopville, S. C. A roadster, going at a high rate of speed, got out of control and slurred from side to side along the road as it careened toward a car pulled over to one side to let it pass. Just before reaching the parked car, the roadster somersaulted up an embankment and, righting itself, leaped on top of the standing automobile, where it remained perched until removed.

Neither car was seriously damaged and none of the occupants was hurt. The roof of the under car surprisingly withstood the terrific impact of more than fifteen hundred pounds crashing upon it. Not one of the supports was broken.

Radio Brakemen for Trains

SIGNALS that ride the ether waves are taking the place of brakemen who used to race along the tops of freight cars swinging lanterns, to relay messages from the caboose to the locomotive. The New York Central Railroad has just asked the Radio Commission for two commercial licenses for a special communication system between the caboose and engine of a freight train. The sets will operate on fifty watts power or less.

Modern freight trains are frequently a mile long and the new system of wireless communication is expected to facilitate their movements. For some time experiments have been carried on with wireless communication between the head and the rear of trains, but this is believed to be the first practical application of the scheme to regular freight service.

He Does All the Housework

SPECIMENS of a strange "leapyear bird," that lives in the Arctic, were recently brought to the Field Museum of Natural History, in Chicago. Among these phalaropes, or swimming sandpipers, the female wears bright plumage and does the courting. The male, wearing somber feathers, builds the nest and sits on the eggs until they are hatched. The birds swim many miles from shore in flocks.

And no one was hurt! In this queer accident, the automobile on top did a neat flip-flop and landed on the shoulders of the other.

Power Aqueduct Is Bored Through Italian Alps

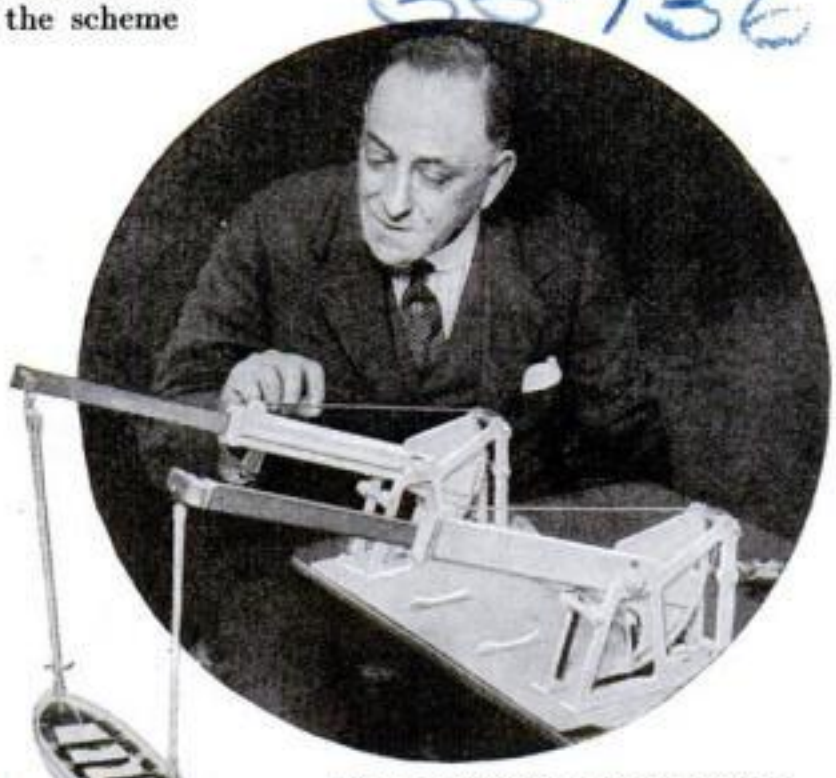
AN ARTERY, carrying water through the heart of a mountain, has just been completed in Italy. The seven-foot bore leads through three and a half miles of solid rock in the Italian Alps, bringing a flow of water from a glacier-fed lake to a power plant in a valley below. When it emerges from the tunnel, which passes 3,000 feet below the peak of a mountain, the water makes a drop of nearly 2,000 feet, almost three times the height of the Woolworth Building, world's tallest building, before striking the turbine wheels of the power plant.

It is estimated that the electricity produced by the new scheme will save Italy the equivalent of 750,000 tons of coal a year. As Italy has little coal, its conservation is of importance. The station will supply power to cities within a radius of 140 miles, including Bologna, Verona, and Mantua.

Extension Davits to Aid in Lifeboat Launching

IN THREE minutes, a new lifeboat launching device will swing a boat twenty-four feet clear of the rail of a sinking vessel, according to its inventor, Henry Lawrence, of London, England. When high seas are running and a foundering vessel is listing badly, the distance a boat can be swung from the side of the ship and the speed with which it can be lowered into the water during momentary lulls are of prime importance. This was demonstrated in the sinking of the British steamer *Vestris* a few months ago, when lifeboats carrying women and children were smashed against the careening side of the vessel.

The usual davits, or curved arms, lower the lifeboats slowly close to the side of the ship. Lawrence's invention has davits with sliding arms that telescope out over the vessel's rail before the boat is lowered.



Henry Lawrence, British inventor, demonstrates model of his extension davits for safer launching of lifeboats.

Native workmen dragging a sledge loaded with a magnificent basalt panel found in temple ruins at Beisan, Palestine, by the University of Pennsylvania Museum expedition.

The great stepped altar at which the Canaanites worshiped their god Mekal 3,500 years ago. It is said to be the most remarkable structure of the kind ever discovered in Western Asia.

Altar 3,500 Years Old Is Unearthed in Palestine

ARCHEOLOGISTS of the University of Pennsylvania Museum expedition to Palestine recently unearthed a great stepped altar at which the Canaanites worshiped their god Mekal about 3,500 years ago—approximately 400 years before the Hebrew tribes from Egypt crossed the Jordan into the Promised Land. The Canaanites, according to the Old Testament, were the descendants of Canaan, the son of Ham and grandson of Noah.

The altar, found in the Mekal Temple at Beisan, the Biblical Beth-Shan, is sixteen feet ten inches wide, eleven feet ten inches deep, and about three feet high. It is made of bricks resting upon a foundation of undressed stone. It contains four steps, the lowest of which is much wider than the upper one, and has a balustrade on either side. Archeologists consider the structure the most remarkable of its kind ever excavated in Western Asia.

Next to the altar, members of the expedition discovered a small room containing a low seat and also a sloping socket that was once used to hold a wooden peg. From its position and appearance, they deduced that this room was occupied by the temple guardian who kept watch with the aid of a fierce hunting dog, probably tethered to the peg.

A number of objects of great archeological importance were uncovered by the expedition, including three gold pendants, one of which bears the figure of the goddess Ashtoreth and a number of bronze arrowheads.

In connection with the find of the guardian's room and the peg socket for the watchdog, leaders explain that some time ago the party found a magnificent basalt panel depicting lions fighting with dogs. They believe this panel was placed against the door of the temple and that the dog was represented as defending the temple against a lion symbolical of destruction and death.

OUT of the dust of ages, archeologists bring us the story of the beginnings of civilization. From the deeds and works of the present, writers for POPULAR SCIENCE MONTHLY report the story of modern progress and build a picture of the future. The scores of stories and pictures on these pages each month represent history in the making. Every issue keeps you up-to-date with the swiftly moving age in which we live.

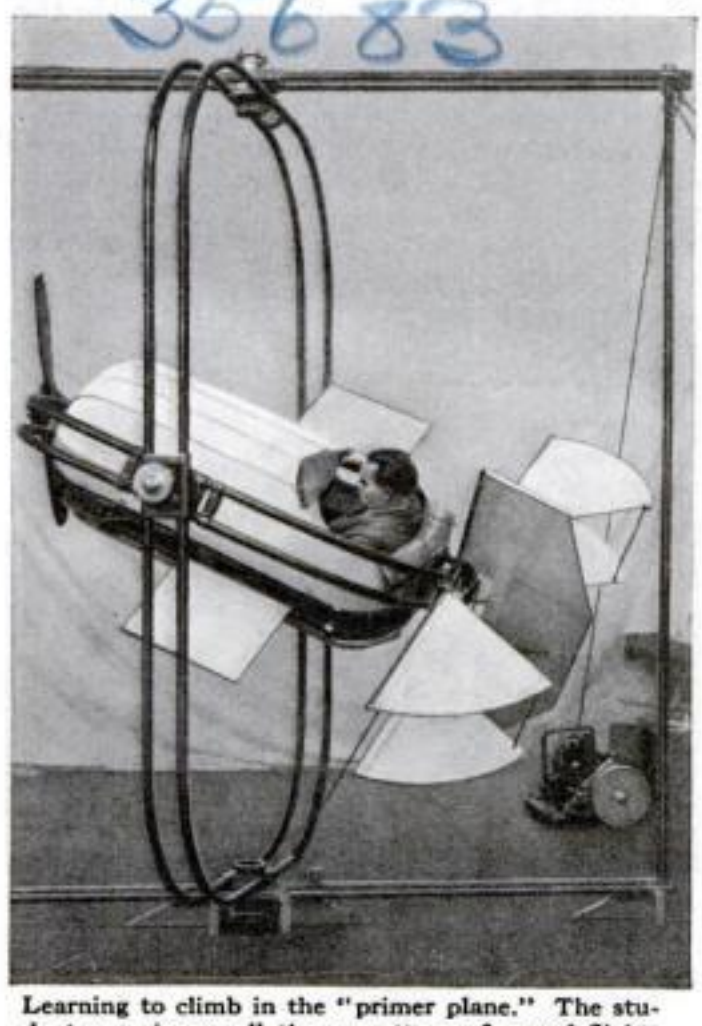
Skipping Heartbeat Not Always Danger Sign

IF YOUR heart beats irregularly at times, it does not mean that there is anything wrong with it. Normal hearts are often irregular, says Dr. Milton J. Raisbeck, of New York City. Extra beats, he believes, are carefully planned by Nature to insure continued beating. Some cells of the heart are pacemakers, governing the rate of beat, as a timer in an auto regulates the rate of explosion.

These "timer" cells change their pace, especially when you rest after exercising. When the change comes quickly, Dr. Raisbeck explains, some of the cells are unable to keep to the pace and the heart gives extra or irregular beats.

Students Now "Fly" without Leaving Ground

ALL the sensations of looping the loop, going into a tail spin, and flying blind through fog are afforded students of the Army Air Corps at Wright Field, Dayton, Ohio, by an ingenious "primer plane" that never leaves the ground. A miniature fuselage, fitted with a propeller, ailerons, elevators, and rudder, is attached to an electrically-operated framework, and in the cockpit a prospective pilot does his first "flying" in safety.



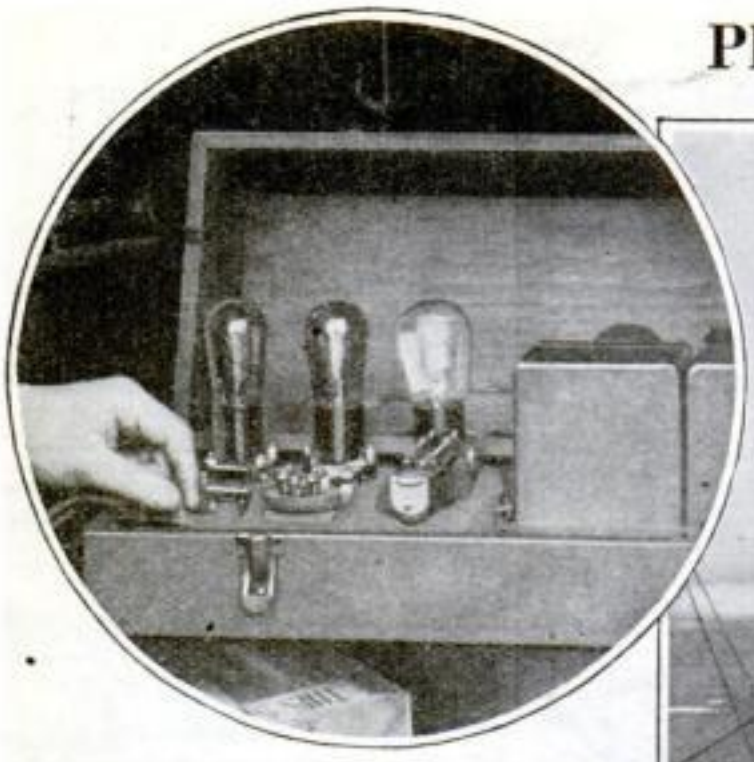
Learning to climb in the "primer plane." The student experiences all the sensations of a real flight.

With his feet on the rudder bar and his hand on the "joy" stick, with the propeller roaring before him and the air rushing past, the student puts the device through various evolutions. Each movement of the control stick or rudder bar results in the same reaction that follows such a movement in actual flight. Thus, the beginner becomes familiar with the controls without risking a crash.

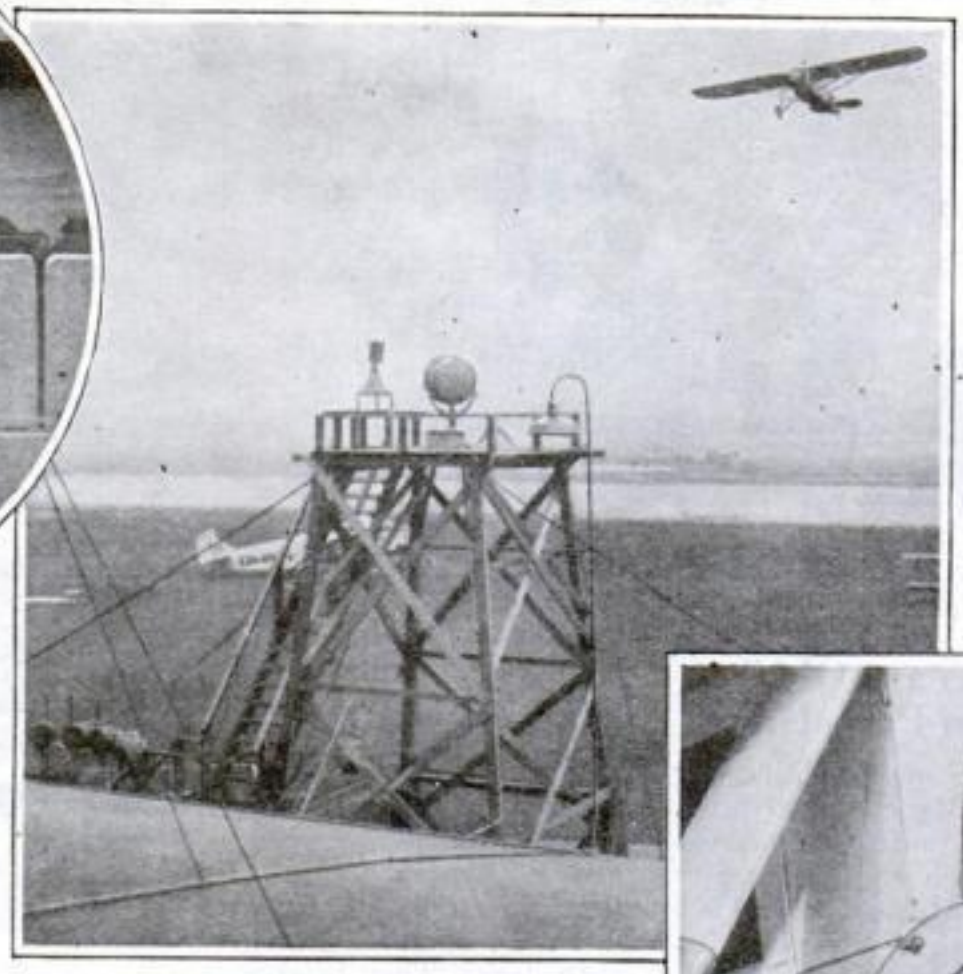
A second lever and bar allows an instructor, outside the device, to maneuver it suddenly into all sorts of positions to test the student's ability to react coolly in a crisis. If an error is made, the motor is shut off and a conference takes place.

On the instrument board of the "primer plane" practically all the instruments carried in a regular airplane are mounted. "Blind" flying is taught by placing over the student's head a hood that shuts off the horizon but permits him to watch his instruments.

Plane's Siren Switches on Airport Lights!

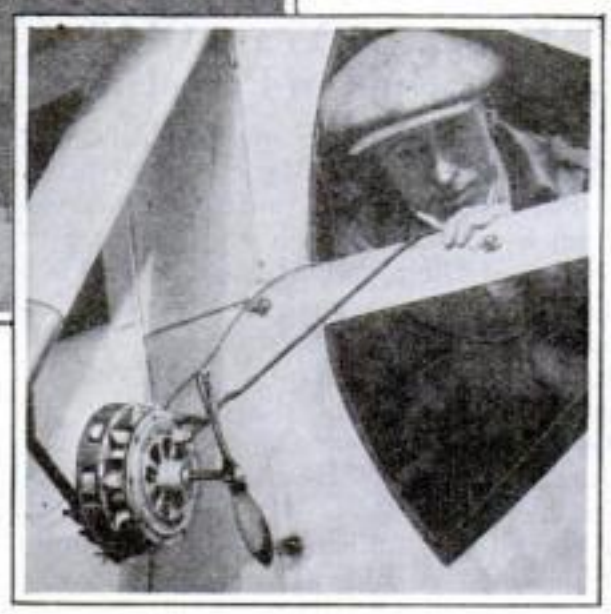


Grid-glow tube receiver which turns on lights in response to sound of a plane's siren.



Left: A monoplane equipped with siren passing above the "electric ear" perched above a hangar at the Newark, N. J., airport. At the lower left are the floodlights, turned on by the siren's sound.

Below: An air-mail pilot pulling the cord which sounds the wind-driven siren seen at the left of the cockpit. A small propeller whirled by wind rushing past the plane in flight operates the siren.



THE other night an air-mail pilot circled over the darkened airport at Newark, N. J. Reaching out of the cockpit, he pulled a cord. A wind-operated siren, attached to the wing, screamed through the darkness. Instantly a blaze of lights, totaling 24,000,000 candlepower, flooded every corner of the huge landing field below. That pull on the cord had turned them on by sound!

A sensitive "electric ear" on the ground had caught the sound of the siren and had relayed the signal to a robot that threw the light switch. The latest attempt at automatic control of airport lighting had proved a success.

Some time ago, attempts were made to have the sound of an airplane motor, as it approached a field in the dark, turn on the lights. The device worked too well. Every time a motor on the field was started, its noise was picked up by the apparatus and the lights flashed on!

The latest method eliminates this difficulty, for the robot is set in action only by the high-pitched note of the siren. The "electric ear" which catches the sound is somewhat similar to a radio receiving set. A radio receiver is tuned to receive certain wave lengths. This device is tuned to receive certain tone frequencies. When the pitch of the siren note rises to a certain frequency, the device responds by setting up electrical impulses. These pass through grid-glow tubes and relays that amplify the impulses until they are strong enough to actuate the "televox" robot to turn on the light switch. A small propeller, turned by the rush of wind past the plane, operates the siren, which can be set for any desired tone frequency. The "electric ear" can be adjusted to respond to that pitch.

Beebe Angles for Strange Fish with Radium Bait

THE rarest fish bait in the world will be used by William Beebe, famous deep-sea hunter, when he lowers hooks coated with radium to attract fish in the black waters off the coast of Bermuda. The amount of the precious substance on the hooks will be slight, as they will be coated with a radium paint similar to that used on the hands of luminous watches. The strange hooks are designed for use in water deeper than 1,700 feet where, according to Beebe, complete darkness reigns.

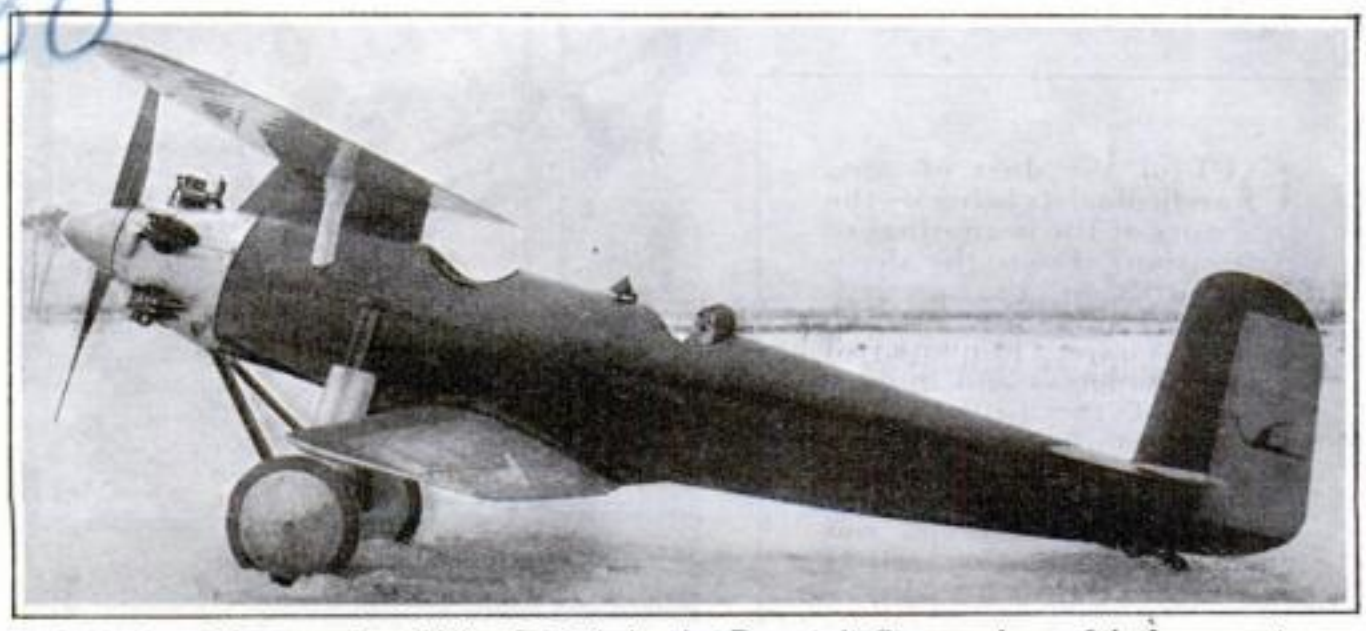
Using Nonsuch Island, near Bermuda, as a base, Beebe and his party, which recently sailed from New York, will comb the ocean thousands of feet below the surface in search of new and rare specimens of sea life. Nets, secured to sounding wires, will be dropped to the ocean bed to catch strange fish for observation. The specimens will be placed in tanks cooled by refrigeration and kept under water pressure approximately that of their original environment. Beebe plans to be gone about six months.

Dark rooms are to be fitted up for studying luminous tropical fish. To collect surface specimens, Beebe will use percussion caps to stun the fish so he can pick them out of the water.

New Biplane Goes the Limit in Wing Stagger

DESIGNED at Darmstadt, the birthplace of the record-breaking German gliders, a new motored biplane of unique design is attracting wide attention. The machine is named the D-18, and was designed by Friedrich Fechner. Its wings have an unusual stagger. The top wings are so far ahead of the lower ones that their trailing edges are almost directly above the leading edges of the latter. The theory is that this will give greater lifting power.

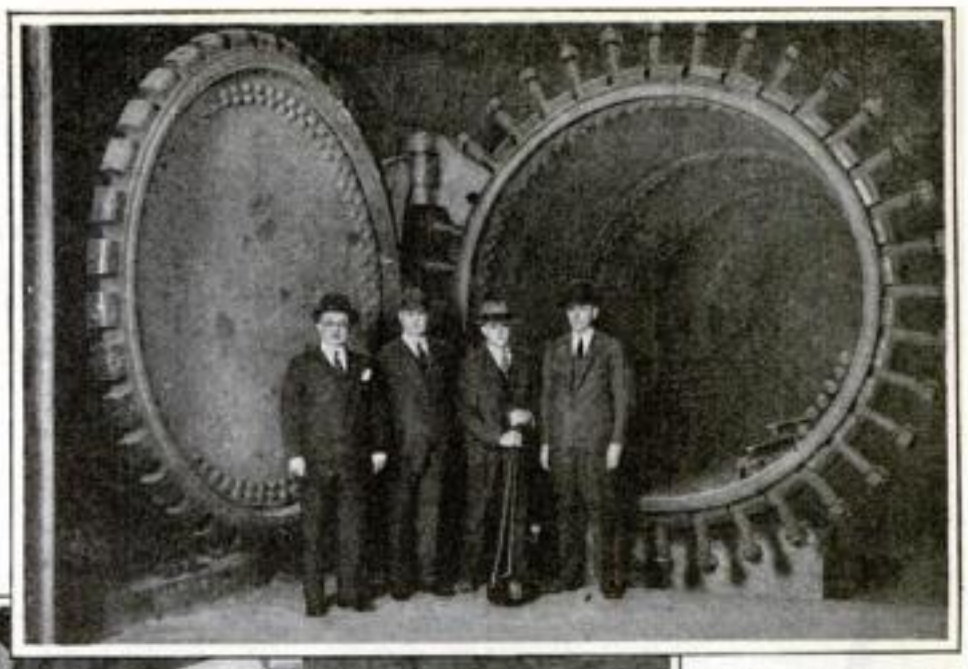
The pilot's cockpit, placed back of the lower wings, is said to give excellent visibility in practically all directions. Like the Darmstadt gliders, the new machine has internally braced wings.

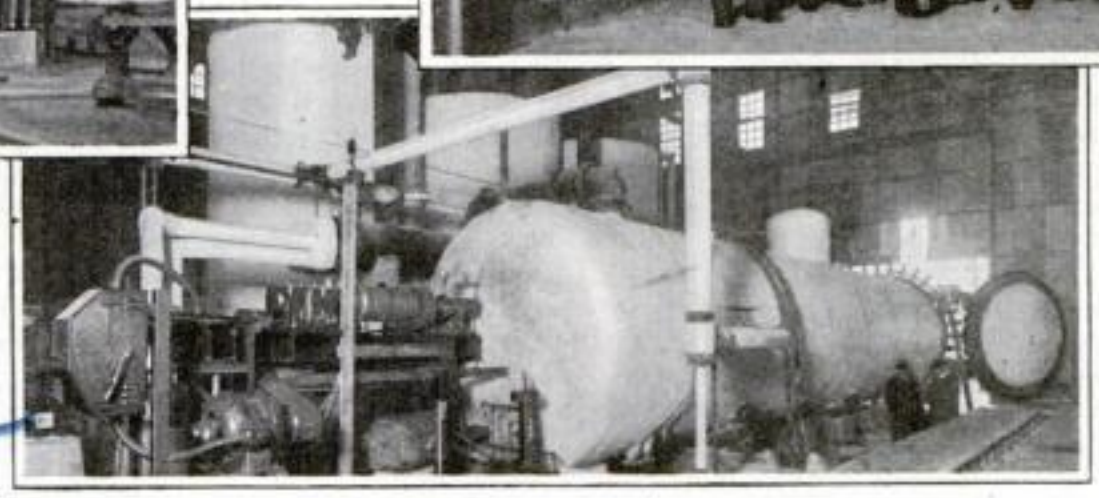


A side view of the unusual new biplane D-18, designed at Darmstadt, Germany, home of the famous motorless gliding machines. Notice how the upper wing has been set far ahead of the lower to increase the lift.

Amazing New Fireproof Lumber Promises Safer Houses

It won't burn! Testing sticks of fireproof lumber over a flame in the laboratory.





Through this eight-foot door, lumber stacked on a car enters a huge cylinder where it is impregnated with fireproofing liquid.

Left: The combination fireproofing and drying cylinder. In the foreground is machinery which extracts lumber's moisture.

GREAT cylinders of steel taller than a man and as long as a freight car make building lumber fireproof, and dry it, in a new process just put in commercial operation. The entire treatment takes but forty-eight hours after the lumber arrives from the sawmill, according to George H. Storm, president of the eastern firm that has developed the process.

A carload of lumber to be treated rolls through the cylinder's eight-foot door, which is then heavily bolted. A vacuum-pump chugs for an hour and a half. Then, at a valve's turning, fireproofing liquid spurts into the cylinder and penetrates to the deepest pores of the wood. A pressure pump forces in the last of a measured number of gallons.

Moisture in the boards is then removed by a recently-invented high speed dryer or vaporizer of unique design, attached to the cylinder. It may be used separately or in conjunction with the fireproofing process. Vapor is circulated in a partial vacuum, drying the lumber in a phenomenally short time without checking or splitting, and leaving the wood soft and resilient. From a condenser attached to the dryer comes running water, by the gallon, actually drawn out of the boards.

Lumber fireproofed by the new process can be used for every part of a private residence, including the shingles; it also offers safety in factories and office buildings and is adaptable for countless other uses. The fireproofing compound itself contains three principal ingredients —one that gives off a flame-extinguishing gas when heated, another that blocks the pores of the wood, and a third that forms a protective surface coating.

Cement Helps Put Out Oil Well Fire

UNUSUAL methods were used recently to conquer two stubborn fires. In an oil well fire near Whittier, Calif., cement was forced down near-by well holes to block them and prevent the spread of the fire while it was being extinguished. When a coal mine caught on fire in the neighborhood of Shenandoah, Pa., a few weeks ago, a creek was diverted from its course and run into the mine to put out the blaze. After the burning coal had been flooded, the creek was turned back into its course.

Would Blast Arctic Ice to Keep Us All Cool

REGULATING the temperature of the world by breaking off ice cakes from Greenland and the Antarctic Continent is suggested by Herbert Janvrin Browne, a meteorologist of Washington, D.C. As we regulate the temperature of a room in winter by opening a window and allowing cold air to come in, so the heat of summers all over the globe can be moderated, he believes, by "opening the windows" of the Arctic and Antarctic and letting more icebergs into the oceans.

The bergs that float down from Greenland into the North Atlantic affect the climate of Europe favorably and prevent droughts, Browne points out; and the Antarctic ice, carried northward, has a similar beneficial effect upon the climate of Australia.

The plan suggested is for the countries of the world to coöperate by sending battleships to shoot off huge chunks of ice from Greenland and the Antarctic. Browne thinks the bergs can be started at points where known ocean currents will carry them to positions in the ocean where their cooling effect is needed.

Tail Lamps for Elephants the Law in Ceylon

BUMPING into elephants in the dark became such an annoyance for motorists in Kandy, central Ceylon, that they induced the municipal council to pass an ordinance compelling all elephants to wear lights. In the dark, the huge, shadowy, gray beasts of burden cannot be seen until the automobile is almost upon them. The law requires the animals to be provided with head and tail lights.

Milk Now Delivered in Handy Paper Bottles

Filling new paper bottles at the milk distributing station. The containers are treated with paraffin to make them leak-proof.

A SPEEDY motorcycle, it is said, can haul as much milk in new paper containers, recently introduced by a New York dairy concern, as a wagon can deliver in glass bottles.

The cone-shaped containers can be packed upright and inverted so that two quarts occupy little more space than a one-quart bottle. Moreover, two quarts in paper containers are said to weigh only seven ounces more than one quart in a bottle.

Before filling, the containers are paraffined to make them leak-proof and air-tight. After filling, the top is sealed with a metal clip. To open the new paper bottles, the top is cut off below this clip.

Comfort Behind Brick Walls

A Noted Architect Tells, from Actual Experience, How to Combine Charm and Durability in an Economical Home

By WILLIAM DEWEY FOSTER

ARCHITECTS frequently, and home builders as a rule, are more interested in the design and appearance of a house than in the materials and methods used in its construction. This is because many architects are at heart artists rather than constructors, while the general public is not aware of the importance of structural details. Yet hidden away in the detailed problems of house engineering are many of the factors which determine the value of a house and the satisfaction it will give.

A striking example of how simple, sound construction can be combined with outward charm and rigid economy is a brick-walled house built in Ravinia, a suburb of Chicago, by Harry Howe Bentley, architect, for about $12,500. The cost was kept down by eliminating unnecessary details and by dependence on simple materials.

The outstanding feature of this house is the method of building the brick walls, but first I wish to give you an idea of its specifications.

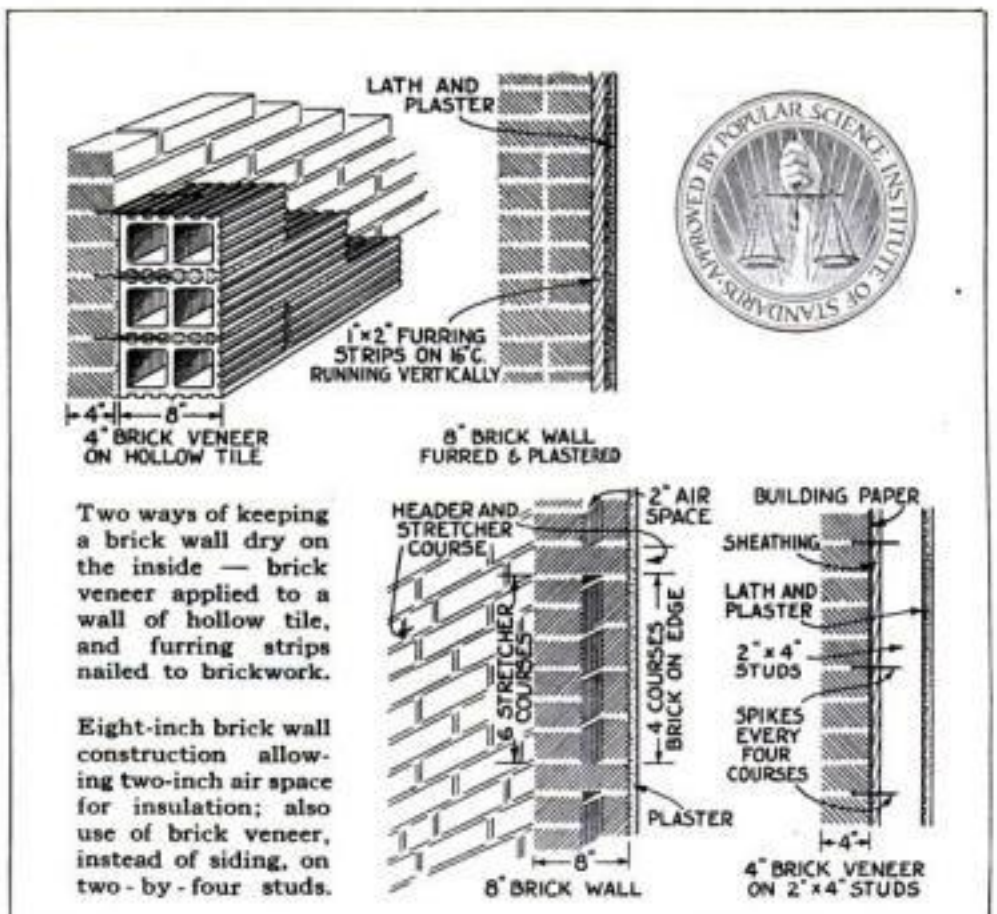
The foundation walls are of concrete and inclose a cellar which is under only the central portion of the house, merely enough for the heating plant, coal storage, and a small laundry. This small cellar, of course, saved on the cost of excavation and also permitted the use of brick for the floors of the breakfast room and kitchen without special floor slabs, as would have been necessary if it were excavated under that portion.

REINFORCED concrete floor slabs were used, however, for all the second floor except over the living room; that is, where the fire hazard was greatest, especially over the garage and kitchen. In addition, a concrete slab under the entry forms the top of the coal storage space, making that area tight against dirt and coal dust.

The living room, then, is the only space in the first story where there is a wood floor, and it is of edge-grained fir, seven eighths by two and a half inches. Over the living room is a single flooring of yellow pine planks about six inches wide and one and five eighths inches thick. These planks span across six-by-eight-inch beams which are spaced three feet six inches on centers, forming an exposed ceiling, no plaster being used. While the beams are heavier than the usual floor joists, their weight permits spacing them farther apart so that the cost is about the same, though the effect is much finer. The planks are tongue-and-grooved, making them tight, and are heavy enough to deaden most sounds.

On the remainder of the second floor, where the concrete slabs occur, the floor has been covered with linoleum. This is, perhaps, a luxury, but it gives a permanent surface which is easily cleaned.

There are eight-inch hollow brick walls separating the garage from the house, with an automatic fire door to the entry. The remaining partitions in the house are of two-by-four-inch studs of fir covered with wood lath and plaster on the second floor except in the hallway—and also at the stair end of the living room—where molded pine boards have been placed vertically, nailed to horizontal strips on the studs. This is as cheap as where plaster is used and makes an attractive finish.

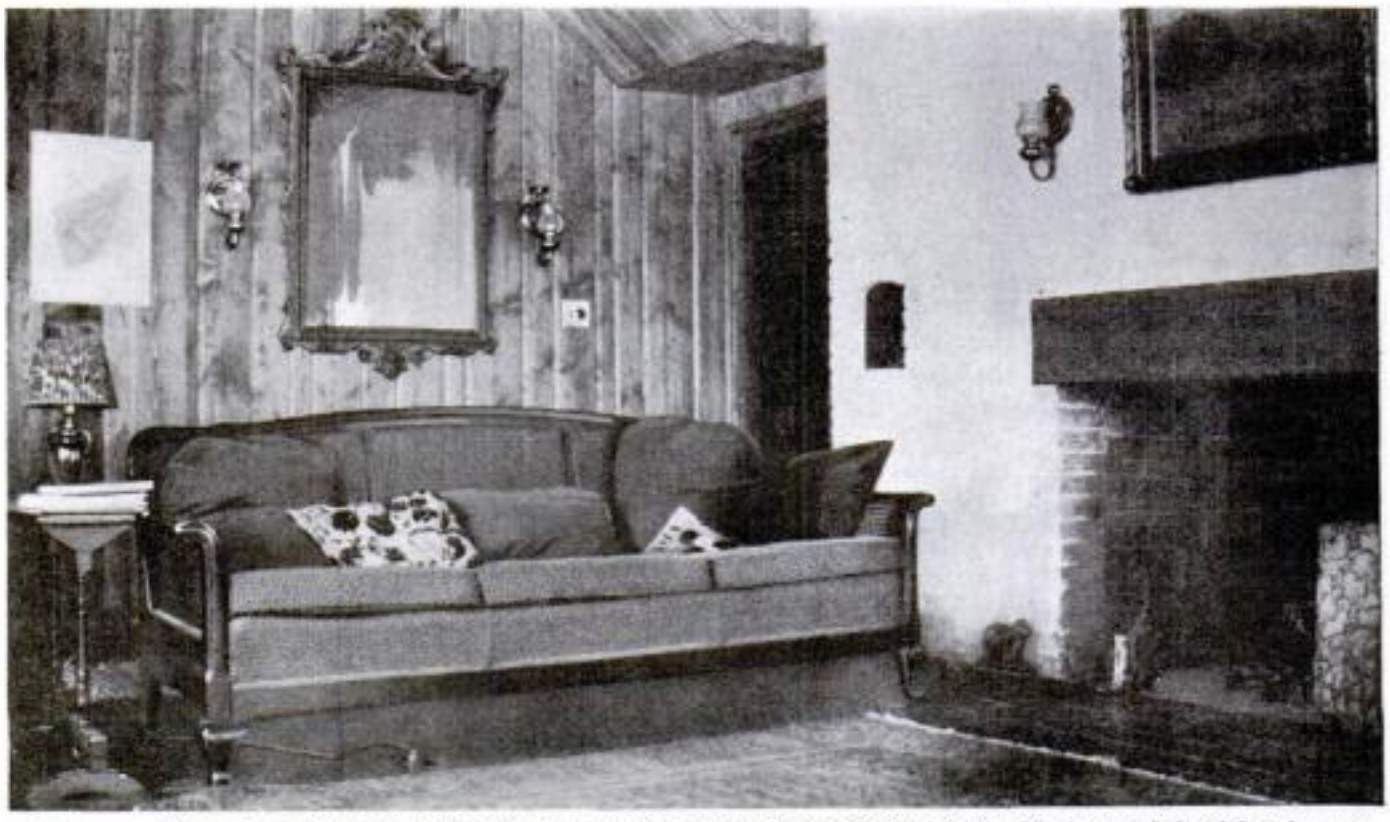


Two ways of keeping a brick wall dry on the inside — brick veneer applied to a wall of hollow tile, and furring strips nailed to brickwork.

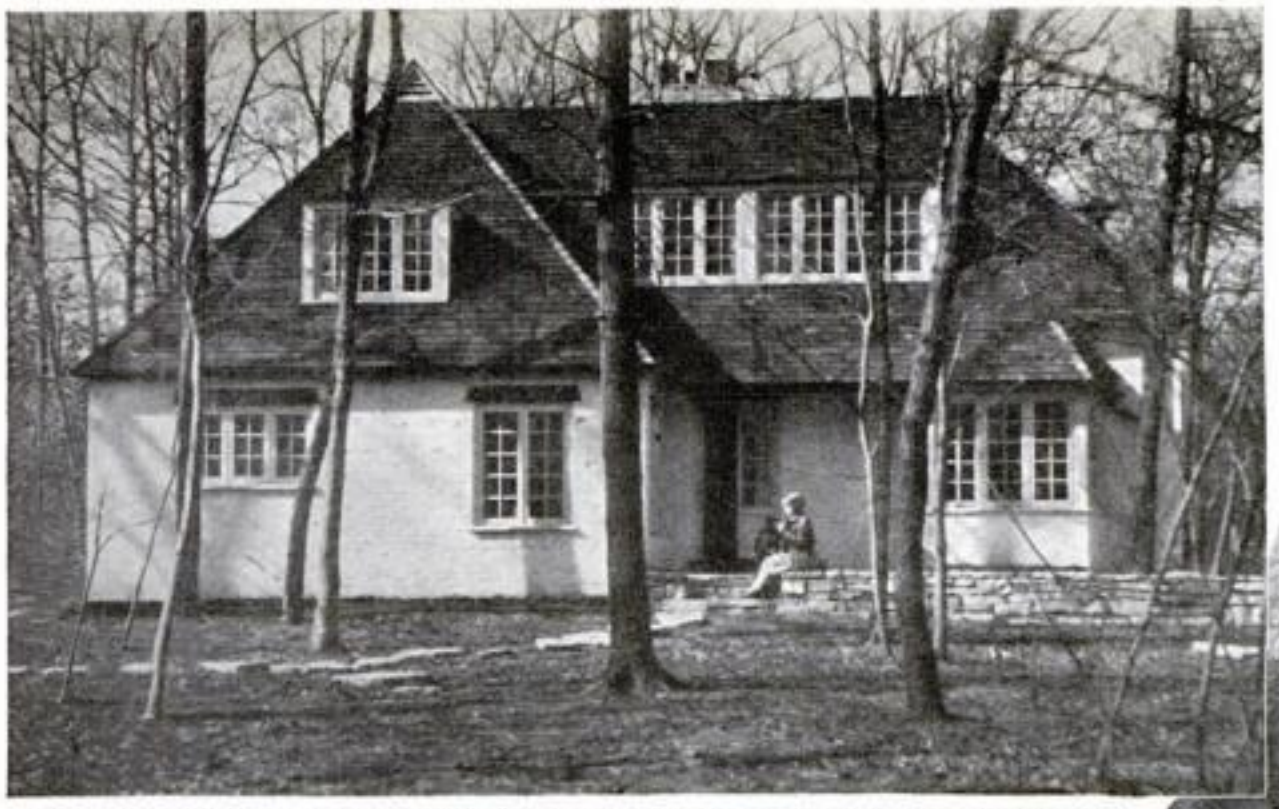
Eight-inch brick wall construction allowing two-inch air space for insulation; also use of brick veneer, instead of siding, on two-by-four studs.

YOU will notice in the photograph of the living room, to the left of the fireplace, a small black door. This is the incinerator door. An incinerator was desired and yet to have one where it could be used from the kitchen would have necessitated another chimney. Accordingly, it was decided to have another flue in the main chimney for the incinerator and use it only when guests were not present. The incinerator itself is in the cellar of the house.

Hot air has been used for the heating system. This is cheaper to install than steam



A corner of the simple but attractive living room in Mr. Bentley's brick home. Notice, at left of fireplace, a small incinerator door. Installing the incinerator in this manner saved the expense of an extra chimney.



Front and rear views of the Bentley brick-walled house at Ravinia, Ill., built for $12,500. The cost was kept down by use of simple materials and the eliminating of nonessentials.

or hot water, and it works satisfactorily in a small compact house.

The roof is covered with sixteen-inch red cedar shingles. Here, again, a fireproof material such as slate or flat shingle tiles would have made a safer and more lasting roof, but for economy wood shingles were used. Well-stained shingles usually will last from fifteen to twenty years.

Copper has been used for all flat roof surfaces and flashings. Poor flashing in these vital spots may cause much damage.

THE brick walls of the house are laid according to what is known as the "ideal" method. This gives a wall eight inches thick, of which two inches is an air space acting as insulation against cold in winter and heat in summer. It also keeps moisture from penetrating to the inside wall. The outside part of the wall is constructed with six courses of bricks laid flat, in the usual way. At the same height on the inside are four courses of bricks on edge, showing the four-inch faces. This gives two practically independent walls, one four inches thick on the outside, and the other two inches thick on the inside, with a two-inch air space between. To tie these two together and form a structurally sound wall, a course is then laid in Flemish bond, which is composed of a "header" (a brick which is laid so that the end shows and the eight-inch length is entirely in the wall), and a "stretcher" (a brick laid flat and showing the eight-inch length on the outside), alternating so that the header carries through the entire eight inches of wall and forms a strong tie, or bond, every seventh course in the height of the wall. A sketch shows how this bonding is effected.

IN PLANNING the home you want to build, the best yardstick, after all, is the actual experience of others who have met the same problems you are facing. In this interesting article an experienced architect leads you through a new brick-walled dwelling and shows you its fine points—its economies and details of construction that spell lasting comfort and satisfaction.

The inner face of the wall, protected by the air space, is dry so that plaster could be applied directly to it, without the usual furring and lathing. In this particular house, however, Mr. Bentley eliminated the plastering for economy, and also because he wanted the effect of exposed interior brick walls. As a finish for the brick he has painted both the inside and outside walls with a creamy white waterproof paint.

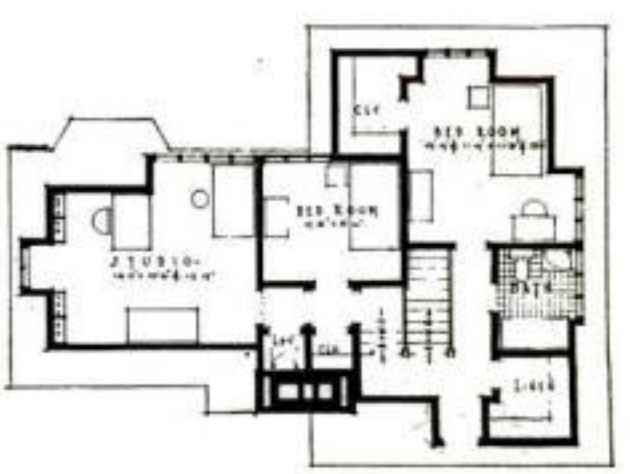
THERE might be some doubt as to the warmth of these walls in winter, but they have proved very efficient. The fuel bill for the past winter, burning coke in the hot-air furnace, was about $130. This low cost no doubt is due not only to the efficiency of the walls, but also to the use of special insulating material for the roof.

The "ideal" method was used here for economy primarily. Undoubtedly it is the cheapest form of brick wall where the inside must be dry, as in a house.

When a solid eight- or twelve-inch brick wall is erected there is chance that moisture will be driven through the mortar joints, and even in some cases through the actual bricks where the side is exposed to driving rains. One way to guard against moisture is to fur the inside of the wall. That is, one-by-two-inch strips laid flat are nailed vertically to the brickwork and then to this is applied lath and plaster, leaving a space between the back of the plaster and the brick. This space of one inch is not always adequate, however, since waste plaster may drop behind the lath and accumulate, forming an area of direct contact between plaster and brick which will conduct moisture and spot the inside wall finish. Heavier furring strips which will give a two-inch space are sometimes used to avoid this difficulty.

A variation of this method is to make the furring the structural part of the building and let the brick be a veneer. In this case two-by-four-inch studs are used, or two-by-six-inch studs if the appearance of a thicker wall is desired; they are erected as for a frame house. Sheathing boards and building paper are then applied to the outside of the studs, as when wood shingles or siding are used. But (Continued on page 147)

First-floor plan of the Bentley house. Hollow brick walls separate the garage from house.

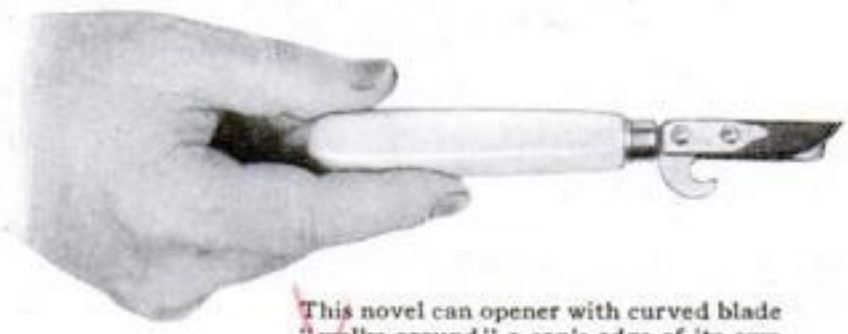


Plan of second floor. Reinforced concrete floor slabs were used, except above living room.

New Devices for Home Makers

Within a handsome table that stands unobtrusively against the wall is concealed a comfortable bed—the latest in space-saving furniture. If an unexpected guest arrives it is opened in a jiffy.

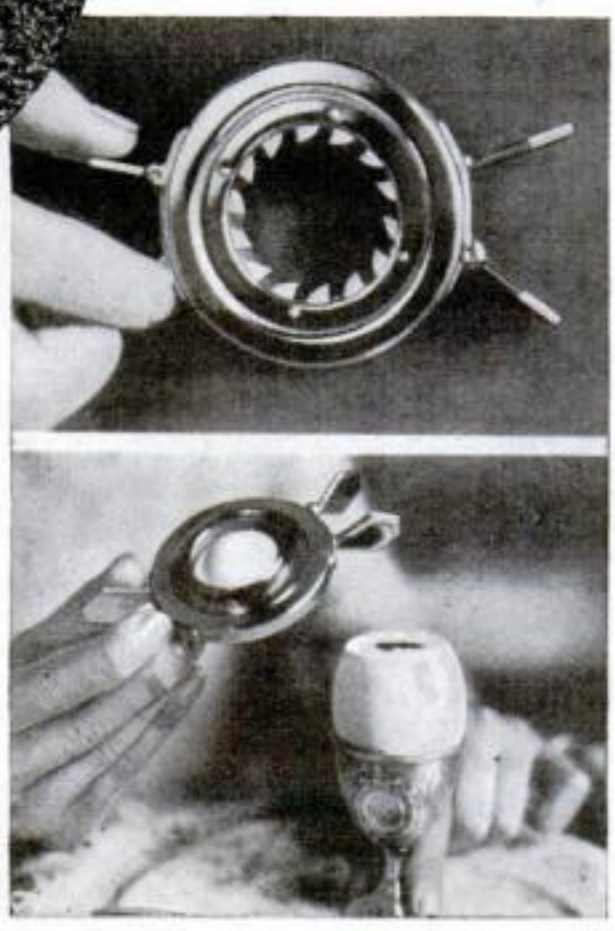
The table-bed opened. A reassuring safeguard for those afraid of being pinned in folding beds is the fact that the table top, backed against the wall, cannot close with the sleeper inside. Both single and double size beds are available.



This novel can opener with curved blade "walks around" a can's edge of its own accord, it is said, when the handle is gently rocked back and forth. A hook on the utensil serves as a bottle opener.

How many inches long? How many feet? You'll never want for an answer, with this handy measuring kit in the house. Hanging against the wall from a hook, it has a series of pockets containing tape measure, foot ruler, and folding yardstick. It is enameled with a bright decorative pattern.

Hedge trimming is made easy with this speedy electric clipper which operates at the end of a hundred-foot cord from any light socket. The cutting knife rotates at 5,000 revolutions a minute, and is said to leave a smooth surface difficult to attain by hand. Since it weighs only five pounds, a woman can operate it easily.



Snip—and off goes the top of the boiled egg. Squeezing the handles on either side of this ingenious egg cutter rotates a series of sharp steel teeth, seen in the upper picture. These slice the shell cleanly and decapitate the egg while it rests in the cup. The Paris restaurateur who invented the device claims that it not only makes the soft-boiled egg look more appetizing, but prevents getting bits of broken shell in the egg and spoiling the breakfast.

Windows can be locked in any position with this device, clamped to the top of the lower sash. Its "business end" is a rubber cap held against upper pane by a spring. Trying to move either sash jams the rubber tightly against the glass and wedges the window fast.

Six little bottles in this handy set contain all the ingredients for removing common spots from clothing. One liquid takes out grass and fruit stains; another, tar; a third, rust and ink spots; and a fourth, grease. Paint and scorch are removed by the two other solutions.

This new lightweight polishing machine has twin brushes of soft hair to produce a shell-like luster. All metal parts are recessed; the machine can operate right up to the baseboard and around table legs.

Electricity now dries the laundry, making the housewife independent of the weather. Adjustable, removable rods in this drying cabinet give a total hanging space of more than thirty feet. It can act as a plate warmer, too.

Designed especially for forwarding soiled clothes through the mail, a stout little case of fiber board affords an ideal way of sending laundry home. Its light weight assures a low postage rate, while in the corner is a holder in which you may insert an address card.

A dishwasher built into the faucet is one of the latest inventions for lightening the labor of cleaning dinner plates and saucers. A touch of the lever at the center of the faucet diverts water through the upper swinging arm, whence it issues from a nozzle in a powerful spray. Pressing a button on the side of a soap chamber immediately releases a measured quantity of soap powder to aid in the washing.

An unusually attractive lighting arrangement for the dining table, sideboard, or console combines three electric lamps of the candlestick type with a flower holder as the base. The lamps, with their delicately pleated shades, are obtainable in different colors.

Duplicating an Antique Mirror

At Small Cost You Can Make an Exact Copy of a Fine Old Walnut Frame Ornamented with Graceful Scrolls

By FREDERICK J. BRYANT, Author of *Working Drawings of Colonial Furniture*

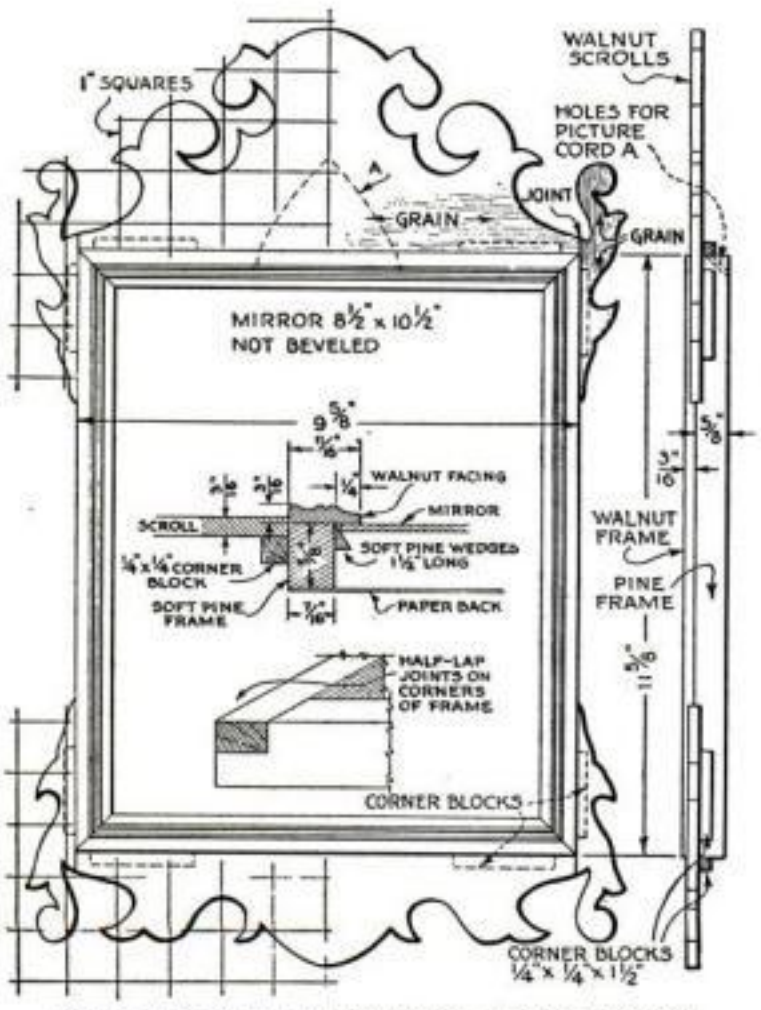
WALNUT is being used so extensively in furniture today that it seems appropriate to suggest a small piece in this beautiful wood for the man or boy who enjoys making furniture in his home workshop. For this reason a small walnut scroll mirror has been selected. It is easy to make and will add charm to any room in which it is placed.

The mirror from which the drawing below has been made is an antique and dates back to about the year 1790. Reproductions of this style are quite popular. It is interesting to note that almost all of the walnut mirrors made between 1775 and 1800 had scrolls similar to this one, so the irregular outline is not a "hit-and-miss" pattern.

General directions will be given for making an exact copy of the original frame, but if you prefer to have a more modern adaptation, picture molding can be used. It is also possible to take a ready-made frame and add scrolls to carry out the effect; the color or finish in this event will be a matter of personal choice.

This mirror, made about 1790, is a valuable antique, but it can be reproduced easily by any painstaking woodworker.

The materials needed are 2 pcs. pine 7/16 by 5/8 by 11 5/8 in. and 2 pcs. 7/16 by 5/8 by 9 5/8 in. for frame; 8 pine corner blocks 1/4 by 1/4 by 1 1/2 in.; 6 wedge blocks 1/4 by 1/4 by 1 1/2 in.; 1 pc. walnut 3/16 by 4 1/2 by 9 5/8 in., 1 pc. 3/16 by 2 1/2 by 9 5/8 in., and 4 pcs. 3/16 by 1 1/4 by 5 1/4 in., for scrolls; 2 pcs. walnut 3/16 by 11/16 by about 12 in. and 2 pcs. 3/16 by 11/16 by approximately 10 in. for face moldings; 1 pc. paper backing 9 1/2 in. by 11 1/2 in.



Front and edge view of the mirror with an enlarged cross section and a sketch of the half-lap joint. The scrolls are 1/8 in. back from the front face.

First make up the pine frame, 9 5/8 by 11 5/8 in. on the outside, fitting the corners with half-lap joints. Then prepare four facing strips of walnut as shown in the sectional view of the drawing. These pieces measure 3/16 by 11/16 in. and are glued to the pine frame. Each corner joint this time is to be mitered.

Now lay out a half pattern of the top and bottom scrolls on a piece of stiff paper. This is done by drawing 1-in. squares on the paper and marking the points where the scroll outlines intersect the lines. Check your work carefully against the smaller squares shown on the drawing. Only one full size pattern is needed for the side scrolls, as all four are alike. Cut the paper outlines with scissors or a pointed knife.

Place your half patterns on the scroll material and mark around the edges with a sharp pencil. Now turn the patterns over and mark the stock for the opposite sides. This is a sure way of getting both sides alike. Saw the outlines on a jig saw or use a coping saw. Sandpaper the edges before gluing the stock to the frame.

The scrolls should be placed about 1/8 in. from the front face of the frame. Reinforce the work by gluing corner blocks in back of each scroll. Drill two small holes diagonally through the top member of the frame for the picture wire or cord, which is shown by the dotted line *A*.

When you have sandpapered the mirror frame thoroughly, apply one coat of walnut oil stain or wood dye and wipe off the surplus. After the stain is dry, brush on a thin coat of orange shellac. Rub this down with No. 00 or finer sandpaper and give the frame a second coat of shellac, rubbing it similarly. You may apply as many as six coats in this way, unless you prefer to follow the more conventional method of using a filler. In that case, fill the grain of the wood with walnut colored paste wood filler after the coat of stain and before applying any shellac, except, perhaps, one exceedingly thin coat consisting of one part shellac to about three parts alcohol. This so-called "wash" coat of shellac prevents the filler from affecting the stain in any way. After filling the grain, finish with one coat of shellac and two of varnish.

Those who are using picture molding or a ready-made frame may take their choice of stain and shellac, colored brushing lacquer, or enamel.

Painting Over Red Stain

TO APPLY white, cream, or other light tints of paint or enamel over old mahogany colored doors or wood trim is difficult because the red stain is likely to penetrate the finish and give it a pink coloring, no matter how many coats are used. If the mahogany stain has been varnished over, do not remove the varnish; sandpaper it lightly and apply the first coat of paint or enamel undercoat directly on top, adding a small amount of varnish to it.

Sometimes it is almost impossible to stop the red stain from coming through. To remedy this condition shellac, japan coach black thinned with turpentine, and aluminum bronze are used. In a stubborn case, all three may be necessary.

Bowls Made *with a* Hammer

Fig. 1. A shallow bowl 6 in. in diameter —a good size and type for the beginner. That in the right-hand column is 5½ in.

Plain Disks of Copper or Brass Are Beaten Over a Shallow Depression in a Heavy Hardwood Block

By EDWARD THATCHER

MANY different bowl forms of the shallow type may be made by the embossing or "inside hammering" method. A disk of metal is placed over a small hollow carved in the top of a wooden block, and the hammer blow is aimed directly over this hollow each time the metal is struck. The position of the metal over the hollow when the hammer falls determines the shape of the bowl as the work goes on.

The hammering is started in the center and continued around in a spiral fashion, the metal being stretched down in the hollow in much the same way as a piece of cloth is pushed in an embroidery frame. The size of the hollow carved in the block of wood has nothing to do with the size of the bowl; that is determined by the size of the flat disk of copper or brass with which you start and by your skill in hammering.

Large bowls up to 14 or 16 in. in diameter may be made in this way after a little experience, but they should be hammered on a stout canvas bag filled with sand instead of over a hollowed wooden block, as it is difficult to guess where a hollow is under a large bowl. The sand yields under each hammer blow, yet supports the metal under the hammer. If you have not done much of this sort of work, it is better to start with small, shallow bowls 5 or 6 in. in diameter.

Fig. 2. The indentations in this flowerlike bowl, which is 9 in. in diameter, were made with wooden tools by the method shown in Fig. 9.

In making bowls by this method the outside diameter does not change very much for shallow forms; but if the bowl is to be fairly high on the sides, it is usual to allow from one quarter to one third more in diameter than the diameter the finished bowl is to be—this also will depend upon your skill with the hammer. High-sided bowls or vase forms are made in quite another manner, which will be described later in the series. The bowls shown in Figs. 1 and 2 were made on the wooden block.

The wooden block on which the hammering is done may be of maple, beech, or almost any close-grained hardwood, 3 or 4 in. square and about 6 in. long. It may be held in the vise when hammering, or the hammering may be done on the end of a stout log of hardwood about the height of the workbench, fastened to the shop floor with angle irons. Various hollows may be carved in the top of the log. The ordinary size for this sort of work is about 1½ in. in diameter and ½ in. deep. The top edges are well rounded over to meet the flat surface on top of the block, as shown in Fig. 7. The hollow may be carved on the top of the log or block with a gouge and hammered down smooth with the embossing hammer, or it may be burned in with the aid of a red-hot iron rod and then hammered smooth.

The ends of the embossing or silversmith's hammer are only slightly rounded; a sharply rounded hammer like a ball peen hammer will dent the metal too much each time it is struck and leave an unattractive, pebbly surface.

To make one of these bowls, cut out a disk of No. 18 or 20 gage copper or brass (copper is much easier to hammer than brass). See that it is well annealed and flat and also as clean as possible, as any dirt or oxide on the surface of the metal is apt to get hammered in and prove difficult to polish off. In practically (*Continued on page 125*)

Fig. 3. Using the hammer to stretch the metal down at the bottom to form a base for the bowl. Note position of hands.

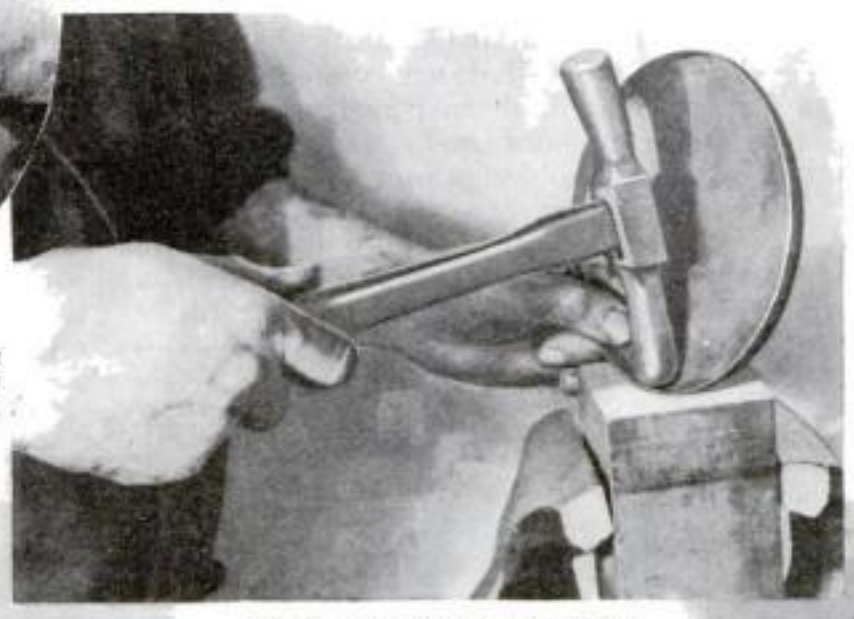


Fig. 4. The hammering is done in gradually larger spirals until the edge of the disk is reached.

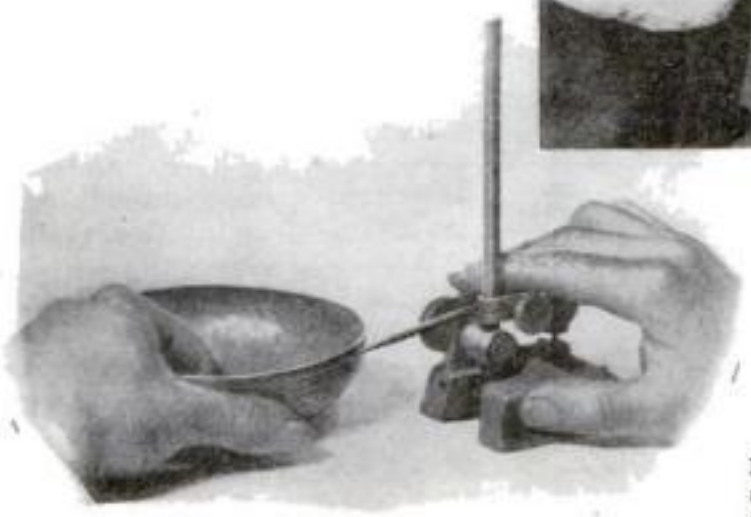


Fig. 6. How to scribe a line around the bowl as a guide for cutting off the surplus metal.

Fig. 5. At the right is shown how a firm base may be obtained by gently driving in the bottom of the bowl.

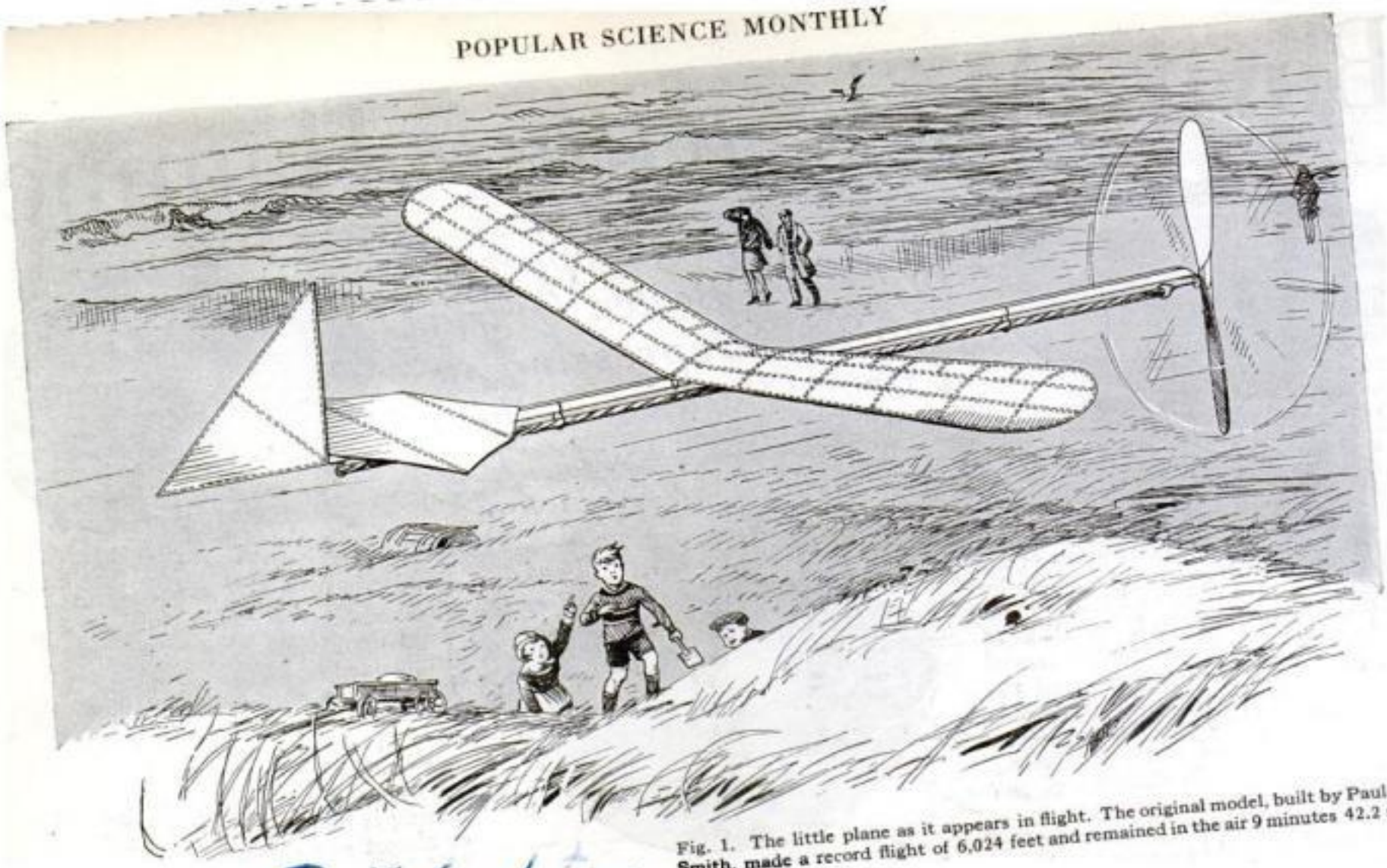


Fig. 1. The little plane as it appears in flight. The original model, built by Paul Shifler-Smith, made a record flight of 6,024 feet and remained in the air 9 minutes 42.2 seconds.

A Model for Long Flights

How to Construct a Duplicate of a Plane Which Holds Two World's Records in the Tractor Class

By VINCENT L. JOHNSTONE, *with permission of Paul Shifler-Smith*

FOR distance and duration in a tractor airplane model, you will find no better design than that developed by Paul Shifler-Smith and illustrated in Fig. 1. His original model (Fig. 3) established what is, at the time this is written, the world's record of 9 minutes 42.2 seconds, and it also set the distance record of 6,024 feet for hand-launched tractor models.

Although the wing of the model is double covered and the motor stick is of the latest hollow spar pattern, you will find the plane is relatively simple to build. The wing, fin, propeller, and rubber motor are detachable so that the model can be carried conveniently to and from the flying field.

Larger drawings of the model than it is possible to publish in the magazine can be obtained by sending for POPULAR SCIENCE MONTHLY Blueprint No. 104 (see page 106).

Besides the materials listed on page 124, you will need small round-nosed pliers, high-grade wire cutting pliers, a sharp knife, Nos. ½ and 00 sandpaper, both large and small camel's-hair paint brushes, several dozen common pins, a ruler, a hard, sharp pencil, some corrugated cardboard, and a metal bar, piece of pipe, or soldering iron for forming the bamboo.

The wing, 4 in. in chord and 36 in. in span, is based upon the German Göttingen 81 wing form. Make the center rib of 1/16-in. balsa wood and the other ten ribs of 1/20-in. balsa, as shown in Fig. Lightening holes are not necessary. I the rear ends in ambroid type cement about 5/8 in. to stiffen them. Also m ten false (short) ribs of 1/20-in. balsa.

Bend a piece of 3/64 by 1/8 in. bamboo the shape of the wing tip, split into halves, and scrape the two tips until t are uniformly 3/64 in. in diameter.

Small 3/64-in. square bamboo pieces tend from the outer rib to support wing tip as shown in Fig. 2. Note the wing beams extend only to the rib and that the front wing beam top and the beam on the tom.

While the ing edge c made of t Shifler-Smit 1/32 by 3/64 in. boo scrapes knife edge rear.

Wing (Figs. 6 must be No. 11 mu to fit the spar snu not so tig they

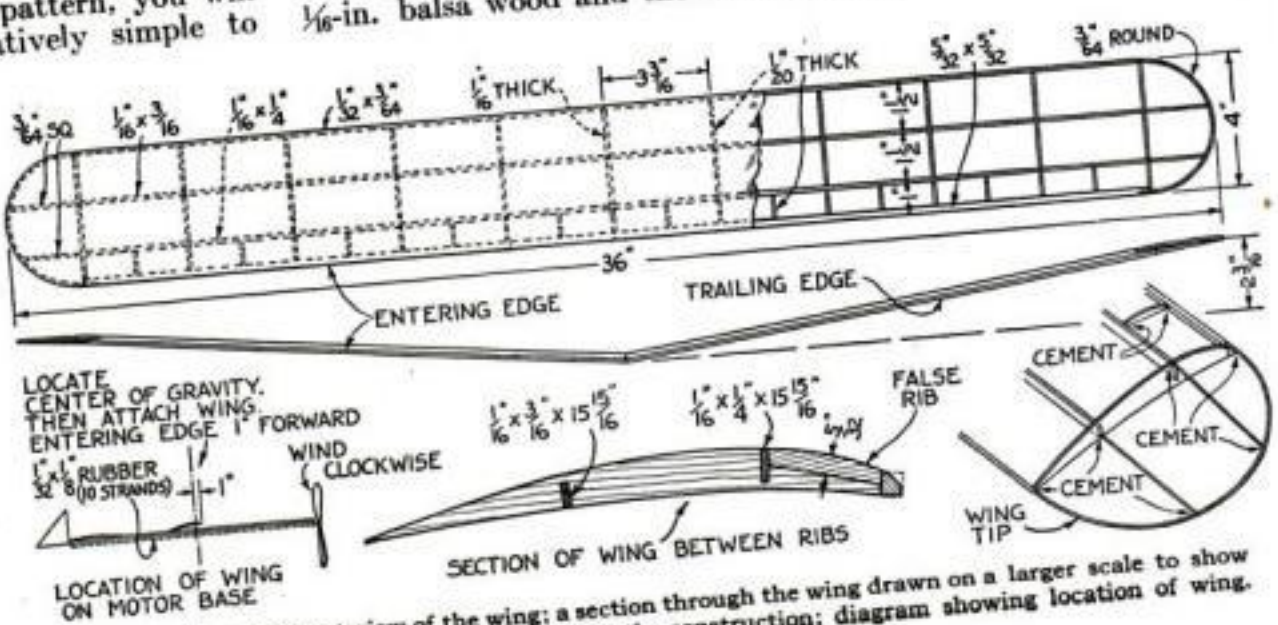
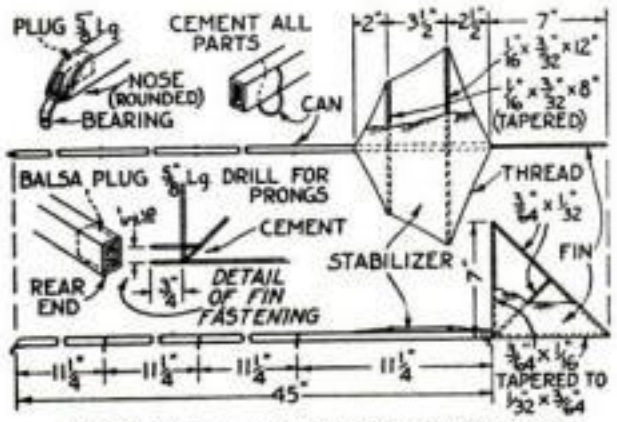


Fig. 2. Top and front view of the wing; a section through the wing drawn on a larger scale to show shape of ribs and false ribs; sketch of the tip construction; diagram showing location of wing.

damage it. The wing should have about a 4-degree incidence; that is, when the trailing edge is flat against the motor stick, the entering edge of the wing should be about 3/32 in. above the stick (Fig. 8).

On corrugated cardboard, make a full size drawing of each half of the wing. Slip the ribs on the beams, line them up, and fasten them with as little cement as possible, although the joints must be strong. Hold the entering edge and the false ribs with pins. Cement the tips and braces. Attach the trailing edge and then join the two halves of the wing together by supporting the tips at 2 3/16 in. above the bench (Fig. 8) and cementing the joints several times, especially on top, and later on the bottom edges of the spars. The sides of the spars need only one coat of cement.

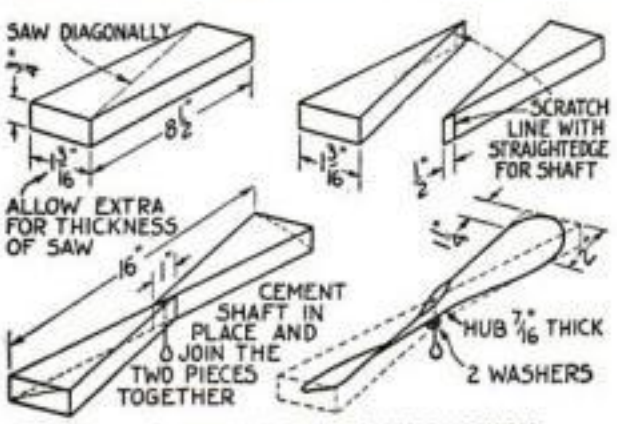
When the cement is dry, attach the wing clips and cover the wing with very light Japanese tissue paper. To get the correct camber on the bottom surface, it will be necessary to stick the paper to each rib, to the rear wing beam, and, of course, to the entering and trailing edges. Dope the wing surfaces, but be careful that the top and bottom surfaces do not stick together. If they adhere anywhere, pull them apart by using a pin stuck through the covering while the dope is yet moist.



MOTOR BASE AND REAR END ASSEMBLY

Fig. 4. The hollow spar or motor stick with horizontal stabilizer. Note the detachable fin.

Before the dope is completely dry, it is most important to twist the wing so that the right wing tip—the right wing viewed from the front—will have about 1/8-in. additional incidence to counteract the propeller torque in flying. You will have to twist the wing considerably more than 1/8 in. because the paper will tend



PROPELLER CONSTRUCTION

Fig. 5. Steps in making the propeller from two triangular shaped pieces of balsa wood.

to pull the surfaces back again. The complete wing should weigh about .4 oz. if it is made with a bamboo trailing edge.

The motor stick (Fig. 4) is a hollow spar, although the model can be made to fly satisfactorily with a solid balsa motor stick and a somewhat smaller propeller. Saw out the 5/16 by 1/2 by 45 in. motor stick in the form of a channel with one of the 5/16-in. sides open, as in Fig. 7. This is best done on a small circular saw. If you have no saw and are unable to purchase

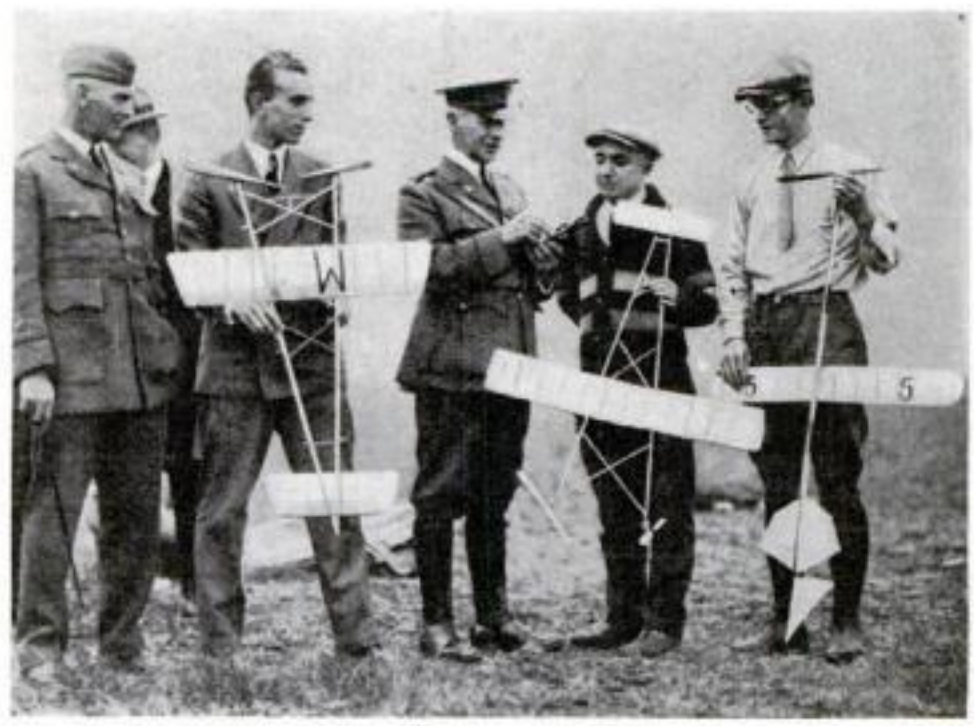
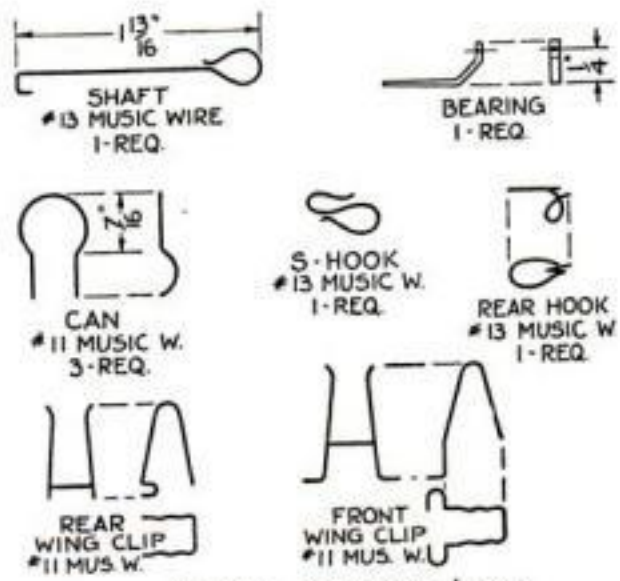


Fig. 3. Paul Shifler-Smith (at the right) with his record model, which won a $100 prize for him. In the center is Maj. Gen. Mason M. Patrick.

a channeled stick from a model supply house, some carpenter or manual training instructor will probably be glad to make it for you. Do not attempt to do it yourself without experience, because of the danger involved.

Sandpaper lightly and uniformly the outside and inside of the channel and prepare a cap strip of 1/16 by 5/16 by 45 in. balsa. Apply a coat of paper cement or thick banana oil to both pieces. When this is dry, lay the cap strip on the chan-

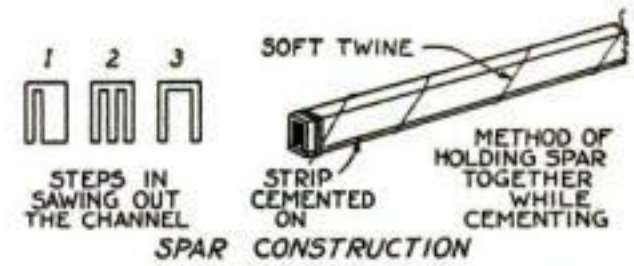


METAL FITTINGS - 1/2 SIZE

Fig. 6. How the "prop" shaft, bearing, "cans," S-hook, rear hook, and wing clips are made.

nel and wrap the two together with soft twine with spiral turns about 1 in. apart. With the stick on a level surface and one of the 1/2-in. sides facing upward, brush paper cement or thick banana oil along the seam the full length. When this is dry, repeat the operation on the other side of the stick.

Without twisting the stick, remove the twine wrapping and paint the seams again, but allow one side to dry before



SPAR CONSTRUCTION

Fig. 7. Method of making the hollow spar of balsa wood and cementing on the cap piece.

brushing the other. It is well to apply two more coats in the same way, making thus four in all. As an added precaution, Shifler-Smith covered his spar with thin Japanese tissue paper cemented with thin banana oil.

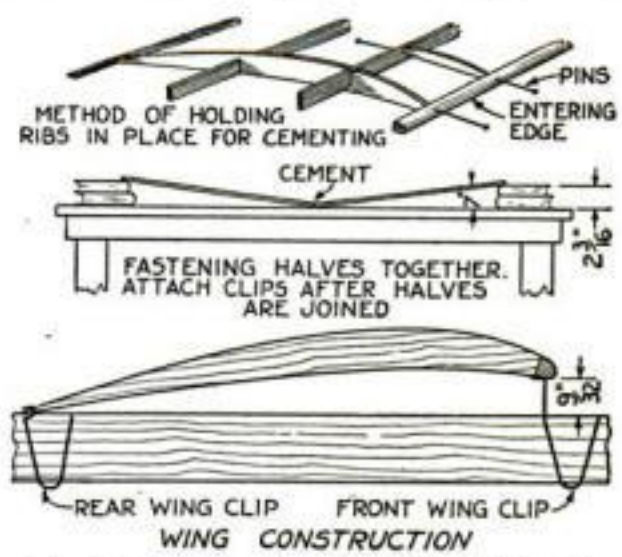
Each end of the spar is plugged with a piece of balsa about 5/8 in. long, cemented in place. The rear is left square but the front is tapered back from the bearing for about 1/2 in., as in Fig. 4.

Cement on three "cans" (Fig. 6) made of No. 11 music wire. One can is placed at the center of the stick and the others at the quarter points, as shown in Fig. 4. One coat of cement is enough for the cans, so that if the rubbers should break in winding they will come off easily without damaging the hollow spar. Use three coats, however, to cement the bearing and rear hook in place.

The horizontal stabilizer (Fig. 4) requires two crosspieces of bamboo, one 12 in. long and tapering from an oval cross section of 1/16 by 3/32 in. at the center to 1/32 by 1/16 at the tip, and the other 8 in. long and of the same oval cross section at the center. These are fastened to the motor base on the top; that is, on the opposite side of the spar from the cans, the bearing, and the rear hook. The edging of the stabilizer is a silk thread.

Use light Japanese tissue paper to cover the surface. It is well to fold the paper over the thread about 1/8 or 3/16 in. If the thread is drawn in as shown, the paper will not sag or wrinkle badly. Treat the surface with light dope. The complete hollow spar should weigh almost exactly 1/2 oz.

The detachable fin (Fig. 4) is triangular and made of bamboo splints cemented together. It has two bamboo prongs which fit into the rear end of the motor base; one of the prongs is merely an extension of the *(Continued on page 124)*



WING CONSTRUCTION

Fig. 8. Fastening the wing ribs, joining the halves of the wings, and applying the clips.

Popular Science
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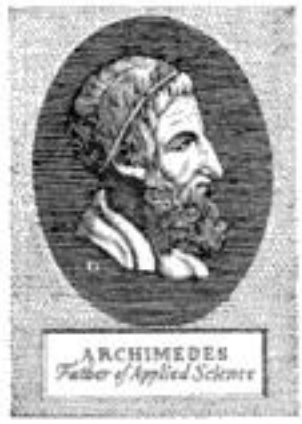

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For the Price of One Tube!

RADIO broadcasting is falling down on the job. We are bothered with interference and whistles, poor reception, inferior programs, and blatant advertising.

The general impression is that interference and kindred troubles are necessary evils, eventually to be eliminated by new engineering developments. That is not so. There is no excuse for interference. Any competent radio engineer, working with knowledge now available, could arrange the location and broadcasting power of a list of stations so as to supply every individual in the United States with a choice of from two to fifty stations, depending on the receiving equipment used. But petty politics, ignorance, sectional jealousies, and short-sighted trade rivalries block all attempts to solve the problem in any such common sense way.

For the poor programs, marred by cheap advertising, we have only ourselves to blame. Broadcasting of the full scores of grand operas direct from the big opera houses, or entire plays and musical comedies from theaters, are entirely possible. But we have had to content ourselves with travesties on them by courtesy of Somebody-or-Other's Hair Oil.

We have paid for our broadcasting in an indirect and presumably inexpensive way. Better programs would be available if the great broadcasting companies were supported directly by the listeners, instead of indirectly by advertisers. This could be accomplished by a licensing system, the annual cost of which to each of the 25,000,000 or more set owners would be not more than the price of one radio vacuum tube!

Get into Aviation!

ELSEWHERE in this issue, Larry Brent, a typical American young man of twenty-two, continues his vivid story of the course in flying he has taken as a prelude to a career as a professional aviator.

No better proof that young Mr. Brent knows what he is about in selecting aviation for his life work could be supplied than a report just issued by Mr. R. L. Putman, a Chicago business man, of a year's use of the airplane for business trips.

Mr. Putman traveled 44,327 miles. It cost him $25,761, or about fifty-eight cents a mile—expensive traveling which, he says, was offset by the conveniences his airplane offered above those of more conventional means of transportation.

The part of his report that concerns young Mr. Brent is the fact that almost half of what he spent went to his pilot and to the mechanics who serviced his plane. The pilot, during the year, received about $8,000; servicing the plane cost about $4,000.

While Mr. Putman's expenditures on his plane show beyond doubt that the time has not yet arrived when airplanes are for the average man, the fact remains that the country every day is becoming more air-minded. There will be more Mr. Putmans to give $8,000 jobs to pilots and to pay generously mechanics who can keep their planes in running order.

Probably no other career offers such glowing opportunities to young men who can qualify for it as does aviation today.

Amazing New Roads Ahead

IN ONE week, recently, about as many automobiles came from American factories as were built in the whole year of 1909. One hundred and twenty-three thousand new cars began speeding up and down the highways.

An interesting question is: How many automobiles will be in the world fifty years hence? How many billion machines will the earth support? Wider highways are coming; elevated roads and underground passages will help relieve traffic. But even so, the earth's road room is limited.

It is safe to say that when the limit is reached, airplanes, flying at different altitudes, will no more have exhausted the room in the sky than the ocean liners of today have congested traffic at sea.

Meanwhile motor cars run by radio power are seen as an "almost certain" development of the twentieth century by G. M. Williams, president of a widely-known automobile concern. To start his car, the owner of such a machine would simply "pull a switch on the instrument board, thereby automatically tuning in on the wave which has been assigned to him." And he would control the speed by turning a rheostat like the knob of a radio set.

Engineers right now are at work on the problem, the solution of which will mean freedom from noxious fumes, the flexibility of electric motors— in short, motor cars the like of which the world has hardly imagined.

Hobnobbing with the Martians

PASSING interest has been aroused by an Englishman's recent attempt to signal to Mars by radio from the powerful Rugby station—an attempt foredoomed to failure. As Dr. J. H. Dellinger, chief engineer of the Federal Radio Commission, explains, a layer of electrified air particles a hundred miles or so above the earth forms an impenetrable barrier to radio waves.

But it is by no means inconceivable that, if there are human beings on Mars, we shall some day find a way to signal to them. Prof. A. M. Low, a leading British physicist, believes that if Martians have telescopes as powerful as our own they could see a smoke signal on our earth fourteen miles long and seven wide. Such a screen could be laid down by a fleet of airplanes. All this, of course, provided that there actually is life on Mars—a moot question to which science has not yet provided a satisfactory answer.

They Are Saying—

"WE DON'T know a millionth of one percent of anything."—Thomas A. Edison.

"There is no reason why we shouldn't have another glacial period."—Dr. V. Nordmann, Danish geologist.

"Lack of proper training during childhood and not lack of ability is responsible for most of the failures in life."—Dr. Sanger Brown, II, New York psychiatrist.

"Ships using airplanes can see further and shoot further and hit harder than any weapon known."—Rear Admiral W. A. Moffett.

"If we are ever to fly as a nation, we must first fly as individuals."—Sherman M. Fairchild, airplane builder.

"Unless active measures are taken to protect the forests of the United States, the country's virgin timber may be exhausted within fifty years."—Paul D. Kelleter, forestry expert.

"A medical student with four years' post-graduate study and two years' hospital work commands less than a chauffeur, a broker's clerk, or a floorwalker."—Dr. Hans Zinsser, bacteriologist, Harvard Medical School.

"The sun cannot be much older than the earth."—Prof. W. Nernst, German physicist.

For the Smoothest Ride over the Roughest Roads to Anywhere

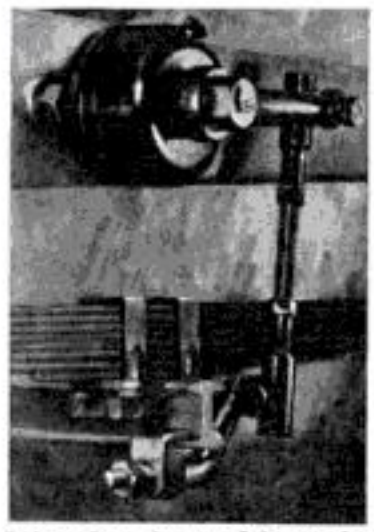
27 YEARS of PIONEERING

THE PIONEERS who blazed trails, harnessed streams, planned cities and linked them together with bands of steel rails, merely paved the way for scores of other pioneers, whose genius and fortitude have contributed a thousand devices for comfort, convenience and easier living.

Such a Pioneer was Maurice Houdaille.

Houdaille's 27 years of *Pioneering* developed the Houdaille hydraulic double acting shock absorber, that made supreme riding comfort available for motor cars.

Houdaille *Pioneering* had its effect in convincing the engineers of Lincoln, Pierce-Arrow, Cunningham, Stearns-Knight, Jordan, Ford, Nash Advanced Six, Chrysler Imperial, Studebaker President and Graham-Paige, to specify Houdailles as standard equipment on these cars. No manufacturer, having adopted Houdailles as standard equipment, has ever given them up.



Prices $50, $75 and $100 plus installation. Slightly higher west of the Rockies and in Canada

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HOUDAILLE

Hydraulic Double Acting SHOCK ABSORBERS

When Valves Get Out of Step

Gus Tells a Stalled Motorist the Secret of Efficient Timing

By MARTIN BUNN

Gus explains how the timing chain, a belt of metal links running on sprockets, makes the motor shaft turn the cam shaft, which operates the valves at exactly the right times.

"THE gas is no good, that's what's the matter," growled the chubby man disgustedly as he banged down the hood of his car, stalled at the side of the road.

"But Theodore," quavered his wife, "the engine was running just a few minutes ago. Why can't you just run it far enough so we can get back to town?"

"That, my dear Elvira, is precisely what I'd like to know how to do. You don't suppose I'm staying here because of the beautiful scenery, do you? We got this bum gas at the Model Garage and, by jinks, I'm going to give 'em a ring and make 'em come and tow me in for nothing!"

He stalked off down the road in search of a phone.

Gus Wilson, veteran auto mechanic and half owner of the Model Garage, drove up in the service car a short time afterward.

"Howdy, folks, sorry to see you've had trouble," he called cheerily.

"You ought to be sorry," snapped the car owner. "It's that bum gas you sold me. Motor won't even run on it. Chugs once in a while when I step on the starter, but it hasn't pep enough to keep on going."

"Try again and let me hear how it sounds," Gus suggested.

The starter spun the motor quite vigorously but only an occasional weak explosion followed.

"That's enough ' said Gus. Quickly he maneuvered the service car around in front of the stalled automobile and hitched on the towing cable.

"Now," said Gus when they reached the Model Garage, "in the first place there's nothing the matter with the gasoline. We've never sold any bad gas, so that's out. In the second place the trouble is in the motor. And in the third place it's getting late. I'll drive you folks home; and tomorrow, Mr. Van Tine, you can drop around and I'll show you what happened to your motor."

THE rotund Mr. Van Tine was waiting when Gus arrived next morning.

"Here's your car," said Gus, "just as we left it last night. To fix what's the matter I've got to take off the radiator, and while I'm doing that I'll explain about it."

"Sure it isn't the gas?" questioned Van Tine, still a trifle skeptical.

"Absolutely," Gus assured him. "The gas had nothing to do with your trouble. This car is several years old and the timing chain is worn out. So are the sprockets. The timing chain, you know, is just a belt made of metal links, and it can wear out same as any other metal part that moves. The timing chain fits around the sprocket on the crank shaft of the motor and the larger sprocket on the cam shaft, so that when the motor shaft turns, the cam shaft operating the valves has to turn, too.

"Of course, all cars don't have timing chains. Some use gears to get the same result. What happened on this car was that the timing chain got so loose it began to jump teeth on the sprockets. Every time it jumped a tooth, the timing of the valves got later, until finally the valves were so far out of time that the motor wouldn't run at all."

"You mean the valves don't open to let the gas into the cylinders?" Van Tine questioned.

"Sure they open," Gus asserted. "As long as the cam shaft keeps turning, the valves will open and close. But the point is that they open and close at the wrong time."

"No teamwork, eh?"

"Exactly," replied Gus as he removed the timing chain case and exposed chain and sprockets. "See how much play there is" he pointed out, as he wabbled the loose chain back and forth.

"CERTAINLY is loose," Van Tine agreed. "I don't see why it stayed on the sprockets at all."

"Lucky for you it didn't come off," said Gus. "Probably would've jammed and busted through the side of the case. Almost anything might have happened."

"How're you going to fix it?" asked Van Tine.

"That depends on how long you expect to keep the car," Gus answered. "If you plan to sell it or trade it for a new model within a few months, perhaps I can take a link out of the chain. It seems loose enough for that. But if you want a real job the only way is to install a new chain and new sprockets. I could put in a new chain on these old sprockets, but it would wear kind of fast."

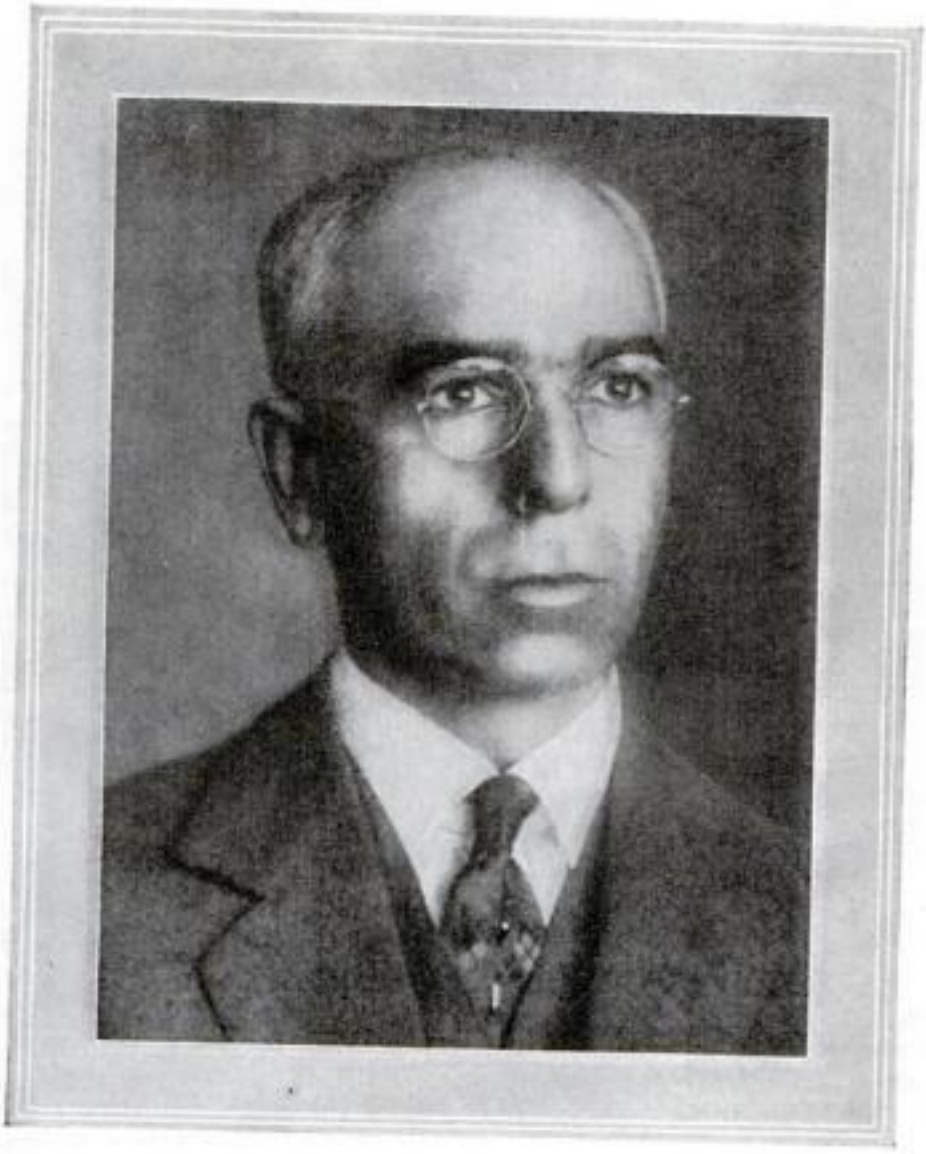
"I guess I won't be buying a new car for a while," said Van Tine. "Better make a good job of it and put in the new chain and sprockets. But tell me, how did you know the chain had slipped? I'd like to know how to spot the trouble, in case it happens again."

"You've got to know how a gasoline motor works before you can understand valve timing," Gus replied. "Lots of people think that the valve just opens, the gas kind of rushes in of its own free will, the spark plug ignites it, and that's all there is to it. They can't seem to get it through their heads that each piston pushes down on the crank shaft only on every other (Continued on page 164)

Ask Gus—He Knows

"SOMETIMES skidding is an accident," says Gus Wilson, "but most times the party behind the wheel is to blame. When the going is slippery watch out particularly for curves, especially if they are not banked. Do your slowing down real slow, which means *don't* jam on the brake.

"The first thing to do when you feel the back end of the car trying to get ahead of the front is to swing the front wheels in the direction in which you are skidding. If the back wheels, for instance, start to slew off to the right and you steer that way real quick and at the same time take your foot off the brake, ten to one you can pull right out of the skid. But Providence will have to be on your side if you steer the front wheels the wrong way, because you're sure to do a right good imitation of atop!"



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This seal on an advertisement in POPULAR SCIENCE MONTHLY signifies the approval of the INSTITUTE OF STANDARDS. See page 8.

How to Cast Concrete Seats

By Making Two Simple Wooden Forms, You Can Turn Out a Number of Good Looking Garden Benches at Low Cost

Concrete garden benches of this type are useful and ornamental.

By LEON H. BAXTER

Supervisor of Manual Arts, Western Reserve Academy, Hudson, Ohio

STURDY garden seats can be made of concrete with but little equipment. Two forms made as shown in the illustration below will serve for making benches for the gardens of an entire neighborhood. A few alert boys working together can make seats for their own yards and sell others to friends and neighbors. As a matter of fact, many of these seats have been made in the course of their school work by boys and girls not more than twelve years old.

The form for the top, or seat portion, is made from 1-in. stock, preferably pine; it should be about 22 in. wide and 4 ft. 10 in. long. As the seat is to be 3 in. thick, the edge pieces should be made 3 by 18 in. for the short sides and 3 in. by 4 ft. 8 in. for the long. Strips cut with a ⅞-in. bevel—that is, triangular pieces—are mitered at the corners and nailed as shown to the sides but not to the bottom board.

Make short cleats to hold the side-pieces in place and screw the sides to the ends with 1½-No. 8 flathead screws. Two pieces for suspending iron dowel pins in the cement are next made and placed in position as shown.

Only one end form is necessary. The curved pieces are best sawed from blocks of pine 4 in. thick, 6 in. wide, and 15½ in. long. The curves may be cut with a turning or web saw, but for a very small expenditure this will be done at a woodworking mill or carpenter's shop on the band saw.

A top and bottom board are screwed on as shown, and well oiled wooden dowels are suspended from the top board (to leave holes in the cement for the iron pins which prevent the seat top from shifting).

Apply linseed oil to all parts that come in contact with the cement mixture. Prepare reinforcing wire and rods as indicated for the seat top, and provide two ¾ by 14½ in. iron rods and sufficient wire mesh to reinforce each of the seat supports. The mesh, or hardware cloth as it is preferably called, should extend to within about 1 in. of the edges all around.

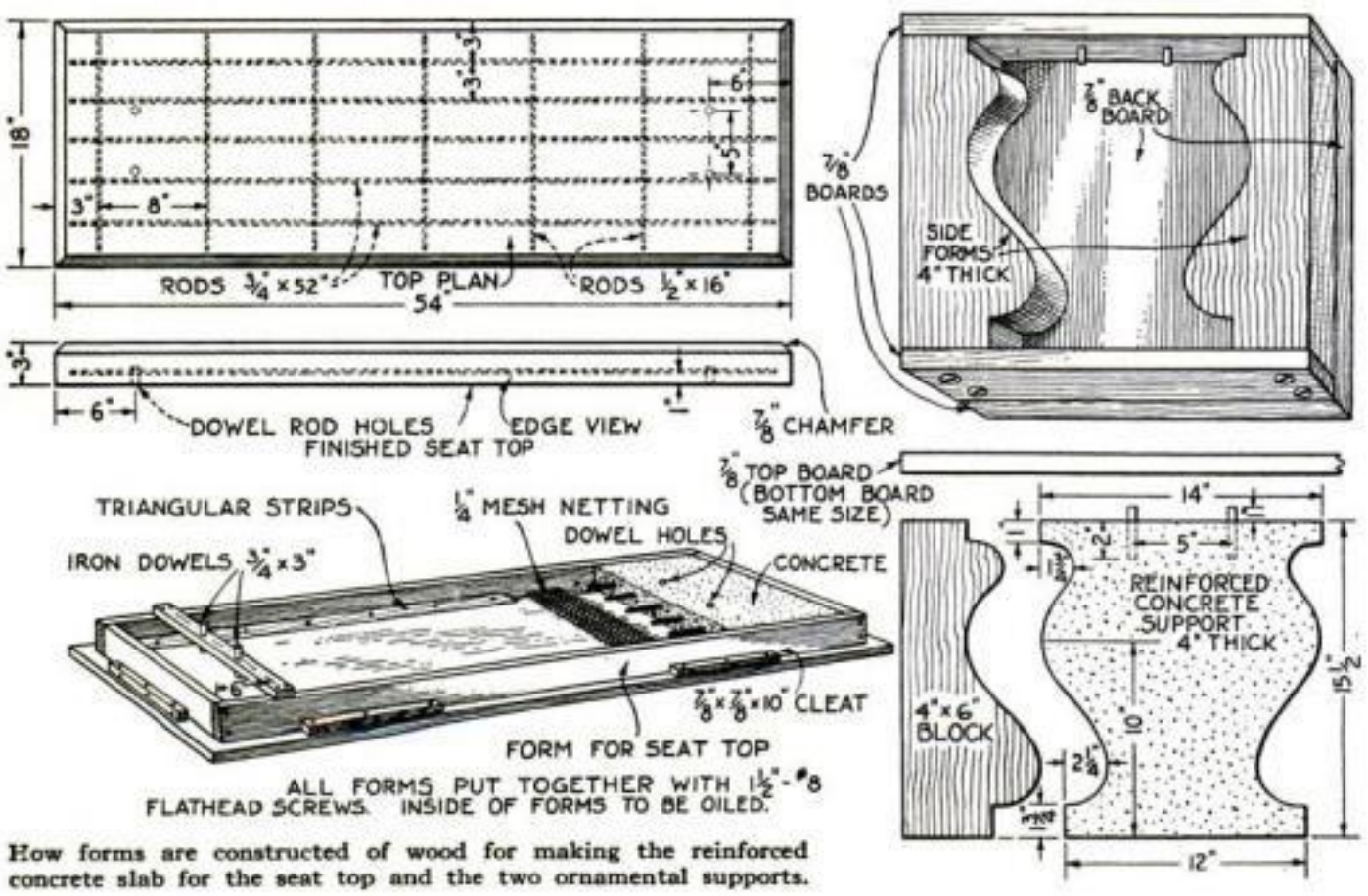
Mix thoroughly one part cement and two parts dry, clean, sharp sand. Cup this up cone shape with a square-nosed shovel and scoop out the center, into which pour enough water to fill the hollow three quarters full. Scrape the sides of the cone into the hollow evenly all around and add enough water to make a quaky mixture.

Take four times as much gravel—running from ¾ to 1½ in. in diameter—as the amount of cement originally used. Wet the gravel thoroughly and work it into the cement and sand mixture. Have the final mixture still of a quaky consistency.

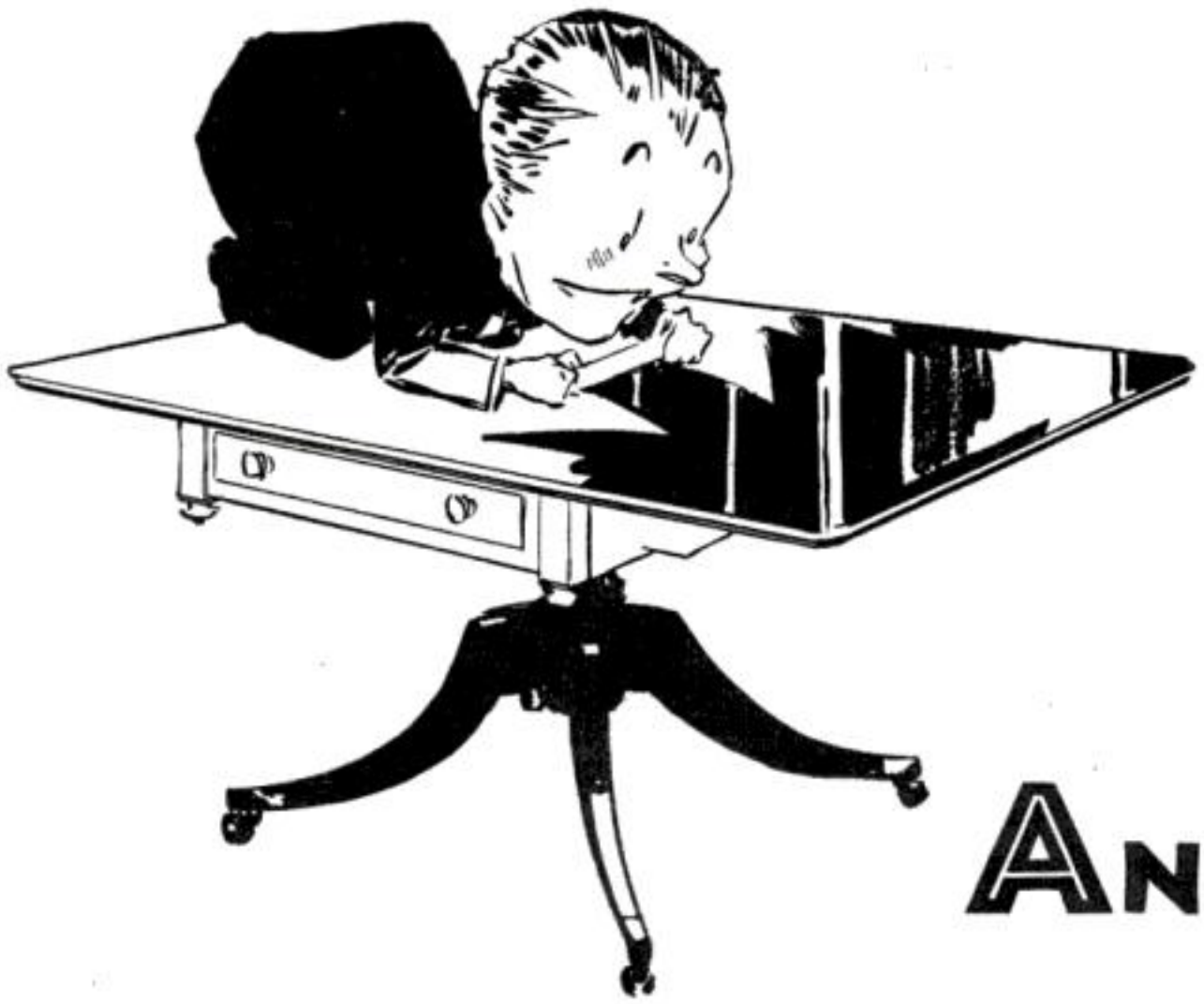
Place the mixture evenly in the forms, working it into corners with a trowel. See that all air pockets are broken up. Allow the concrete to set for half an hour; then smooth the surface lightly with a trowel.

The casting will harden overnight but should remain in the form about three days. Sprinkling it daily will insure its drying out evenly.

To improve the surface and conceal any slight air pockets and roughnesses, apply with a 2-in. paint brush a mixture of one part cement to one part sand. A still more even, smooth surface may be obtained by rubbing the concrete with a carborundum stone or a common brick dipped in cement and water. (*Continued on page 118*)



How forms are constructed of wood for making the reinforced concrete slab for the seat top and the two ornamental supports.



AND . . . .

UNDER THE PAINT LAY RICHES!

WITH what ghoulish glee have countless collectors, amateur and professional, scraped the paint from an old table or chair to find the cherished beauty of walnut or cherry underneath!

Wood is as beautiful today as it was when antiques were being made. The lowly pine and birch of grandfather's day have come even further into their own under the skillful hands of men who know how to bring out their real beauty.

With the skill which Johnson's Wood Dye puts into even the most amateur of hands, there need be no resort to opaque finishes . . . makeshift substitutes for lack of skill in finishing. Without streaks, without laps, the Dye sinks deeply, revealing the full depth and texture of the grain. There is no pigment in Johnson's Wood Dyes (spirit and oil). There is therefore no dirty scum left behind when it is used. It dries quickly and smudge-proof. The subtlest gradations in color, from the darkest to the lightest shades, are available in Johnson Wood Dye.

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Ingenious Ideas for Motorists

How to Check Ignition Timing—An Automatic Light for Luggage Compartments—Timesaving Tools You Can Make

THE ignition system of most cars is so timed that when the spark lever is in full retard position, the spark will occur at top dead center. It is, however, not easy to know just when the breaker points actually part company and cause the spark. You can determine exactly when this happens by the aid of a small mirror. Set it where it will reflect the face of the ammeter, as in Fig. 1, while you turn the hand crank. When the points break and the spark occurs, the ammeter needle will flip back to zero.

You can use this test to check the ignition timing, in which case turn the crank until the needle flips back and then see if the piston is at the top; or to make sure that the piston in any cylinder is at the proper point for setting clearance of the valves. When the spark occurs, both exhaust and intake valves are, of course, closed.

Fig. 1. By watching the ammeter needle in a mirror, as shown, you can see when spark occurs and check the timing.

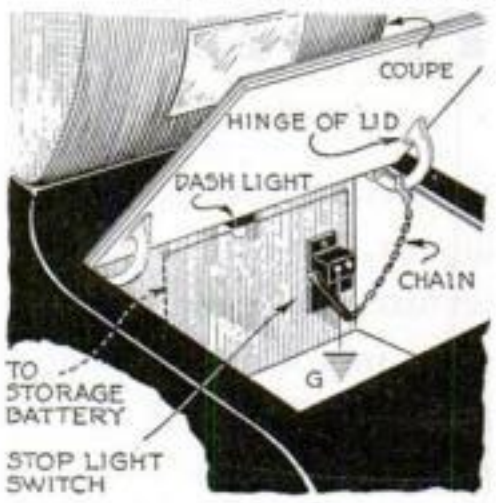


Fig. 2. Automatic light for luggage compartment goes on when lid is up.

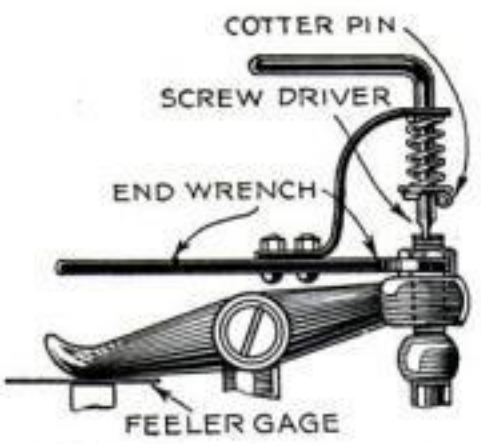


Fig. 3. Timesaving tool for adjusting overhead valves fitted with slotted bolt and lock nut.

An Automatic Light

NO NEED to fish around in the dark trying to find something in the luggage compartment. You can easily arrange an automatic light which will go on when the trapdoor is lifted, and go out when you close it, as in Fig. 2. A socket of the bayonet type to hold a headlight bulb is attached underneath the front edge of the door opening, and a stop-light switch is attached at a point where it can be connected by means of a chain to the hinge or to a screw eye in the door.

The chain should be adjusted with enough slack so that when the door is in a fully opened position, the switch will be thrown on. Run a wire from the ungrounded battery terminal to one terminal of the socket, connect the other terminal of the socket to one terminal of the stop-light switch, and ground the other terminal of the switch to the nearest point on the metal frame of the car.

Fig. 4. Small piece of wood converts pliers into spring compressing tool.

Ten Dollars for an Idea!

H. T. Goshon, of Pasadena, Calif., wins this month's $10 prize for his suggestion of a valve adjusting tool, shown in Fig. 3. Each month POPULAR SCIENCE MONTHLY awards $10, in addition to regular space rates, for the best idea sent in for motorists. Other contributions that are published are paid for at the usual rates.

Valve Adjusting Tool

FIGURE 3 shows a homemade tool that will be a timesaver for either the garage mechanic or the motorist who does his own repairing in adjusting overhead valves that are fitted with a slotted bolt and a lock nut. Its advantage is that you do not have to remove the screw driver from the slot each time you test the clearance between the valve stem and the end of the rocker arm. The spring holds it securely in the slot.

To make this tool, take an end wrench that fits the lock nut. Bend a piece of three-sixteenth-inch cold rolled stock into form, as shown, and bolt the end to the end wrench after drilling a hole for the screw driver bit. A cotter pin, a washer, and a spring complete the assembly.

To use the tool, fit the wrench over the lock nut while pulling the screw driver bit up against the spring. Let the screw driver edge drop into the slot, loosen the lock nut, test the clearance while still holding the wrench in place, turn screw driver to change clearance, and when you have it right hold screw driver in the correct position with one hand while you tighten the lock nut with the other.

This tool has saved much time in the repairing of cars with overhead-valve motors.

Spring Compressor

IF YOU have no spring compressing tool and you wish to remove the retaining pin that fits through a slot in the overhead type of valve spring, you can use a pair of end cutting pliers, as shown in Fig. 4. Into holes drilled in a small piece of wood, set the handle ends of the pliers just far enough apart so that the jaws will clear the valve stem. All that is necessary then is to press down on the wooden handle and remove the pin. Grip a leg of the pliers between the thumb and first finger while you are pressing down to avoid pinching your finger if the pliers slip sidewise.

A Simple Hood Protector

WHILE gasoline has practically no effect on the lacquers used on modern automobiles, it does leave marks which must be polished off. If your car is fitted with a gasoline tank under the cowl, you can avoid spotting by making a protector as shown in Fig. 5. The hole in the protector should fit tightly around the filler opening.

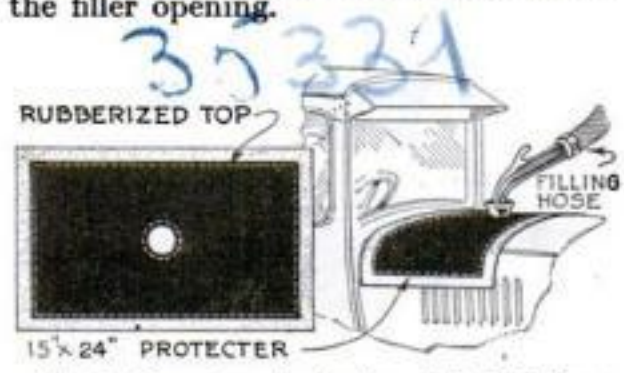
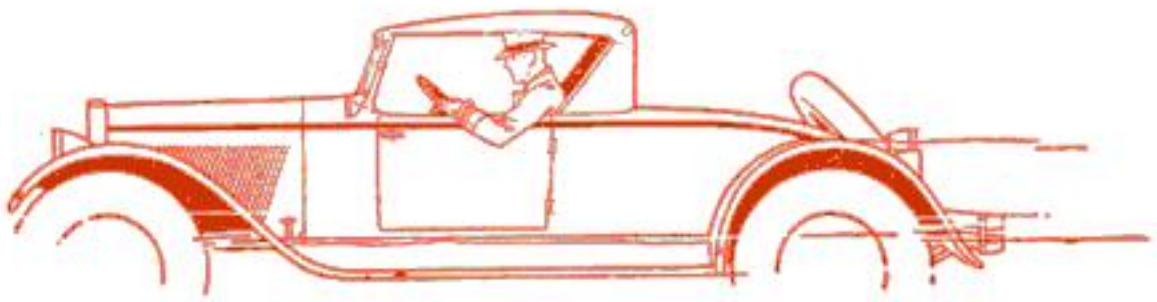


Fig. 5. How to protect automobile finish from gasoline stains when the tank is under the cowl.

Suppose somebody said —

"I can add 10% to 30% more power to your engine.
I can preserve its first-year feel for 30,000 miles."



You'd want to know how and why.

The "how" is the New Mobiloil.

The "why" is told below.

In spite of our scientific prejudice against superlative language, we are prepared to make some very strong statements about the *New Mobiloil.*

For example: We are willing to say that use of the New Mobiloil will help your engine develop 10% to 30% more power than other oils generally sold for the same motor. Our road and laboratory tests have bettered the higher figure.

Our assurance that the amazing New Mobiloil will stand up better and consume more slowly under high speed is a conservative reflection of the speed-test records made in thousands of miles of running at the Atlantic City Speedway. And it is an established engineering fact that the oil which lasts longest and stands up best at high speed, lubricates best at any speed.

We believe that, with regular draining and refilling, and with reasonable care of your car, the New Mobiloil will keep the first-year feel in your new engine for at least 30,000 miles. Actually, Mobiloil has preserved the first-year feel in many engines for more than twice this distance.

The New Mobiloil will give you many thousands of miles of the pleasantest motoring you have ever known and save you many repair bills besides. Mobiloil has been the World's Quality Oil ever since it lubricated the first successful motor car. Mobiloil is made by the Oldest and Largest Specialists in Lubrication.

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for all types of machinery

Make this chart your guide

It shows the correct grade of Gargoyle Mobiloil for certain prominent cars. If your car is not listed below, see complete Mobiloil Chart at your Mobiloil dealer's.

NAMES OF PASSENGER CARS	1929 Engine		1928 Engine		1927 Engine		1926 Engine	
	Summer	Winter	Summer	Winter	Summer	Winter	Summer	Winter
Auburn, 6-66	....	....	....	....	....	....	A	A
" 8-cyl.	BB	Arc.	BB	Arc.	BB	Arc.	A	Arc.
" *other models*	A	Arc.	A	Arc.	A	Arc.	A	A
Buick	BB	Arc.	BB	Arc.	BB	Arc.	A	Arc.
Cadillac	BB	Arc.	BB	Arc.	BB	Arc.	BB	Arc.
Chandler Special Six	....	....	A	Arc.	A	A	....	....
" *other models*	A	Arc.	A	Arc.	A	Arc.	A	Arc.
Chevrolet	A	Arc.	A	Arc.	A	Arc.	A	Arc.
Chrysler, 4-cyl.	....	....	A	Arc.	A	Arc.	A	Arc.
" Imperial	BB	Arc.	BB	Arc.	A	A	A	A
" *other models*	A	Arc.	A	Arc.	A	A	A	A
De Soto	A	Arc.	....	....	....	....	....	....
Dodge Brothers	A	Arc.	A	Arc.	A	Arc.	A	Arc.
Durant	A	Arc.	A	Arc.	....	....	A	Arc.
Erskine	A	Arc.	A	Arc.	A	Arc.	....	....
Essex	A	Arc.	A	Arc.	A	Arc.	A	Arc.
Ford, Model A	A	Arc.	A	Arc.	....	....	....	....
" Model T	....	....	....	....	E	E	E	E
Franklin	BB	Arc.	BB	Arc.	BB	BB	BB	BB
Gardner, 8-cyl.	BB	Arc.	BB	Arc.	BB	Arc.	A	Arc.
" *other models*	....	....	....	....	....	....	A	A
Graham-Paige	BB	Arc.	BB	Arc.	....	....	....	....
Hudson	A	Arc.	A	Arc.	A	Arc.	A	Arc.
Hupmobile	BB	Arc.	BB	Arc.	A	Arc.	A	Arc.
La Salle	BB	Arc.	BB	Arc.	BB	Arc.	....	....
Marmon, 8-cyl.	A	Arc.	A	Arc.	A	Arc.	....	....
" *other models*	....	....	BB	A	A	A	A	A
Moon	A	Arc.	A	Arc.	A	Arc.	A	Arc.
Nash, Adv. & Sp. 6	BB	Arc.	BB	Arc.	BB	Arc.	A	Arc.
" *other models*	A	Arc.	A	Arc.	A	Arc.	A	Arc.
Oakland	A	Arc.	A	Arc.	A	Arc.	A	Arc.
Packard	A	Arc.	A	Arc.	A	Arc.	A	Arc.
Peerless, 72, 90, 91	BB	A	BB	A	BB	A	BB	A
" *other models*	A	Arc.	A	Arc.	A	Arc.	A	Arc.
Plymouth	A	Arc.	....	....	....	....	....	....
Pontiac	A	Arc.	A	Arc.	A	Arc.	A	Arc.
Reo	A	Arc.	A	Arc.	A	Arc.	A	Arc.
Stearns Knight, 6-80	BB	Arc.	BB	Arc.	....	....	....	....
" *other models*	BB	A	BB	A	BB	A	BB	A
Studebaker	A	Arc.	A	Arc.	A	Arc.	A	Arc.
Velie, 8-cyl.	BB	Arc.	BB	Arc.	....	....	....	....
" 6-cyl.	A	Arc.	A	Arc.	A	Arc.	A	Arc.

the New GARGOYLE Mobiloil

Varnishing Your Front Door

What Preparations to Make and Materials to Use—Removing Old Finishes—Stains and Their Application

By F. N. VANDERWALKER, Author of *House Painting Methods*

STAIN and varnish form a popular and satisfactory finish for front doors, provided a high-grade exterior varnish is used and the work is properly done.

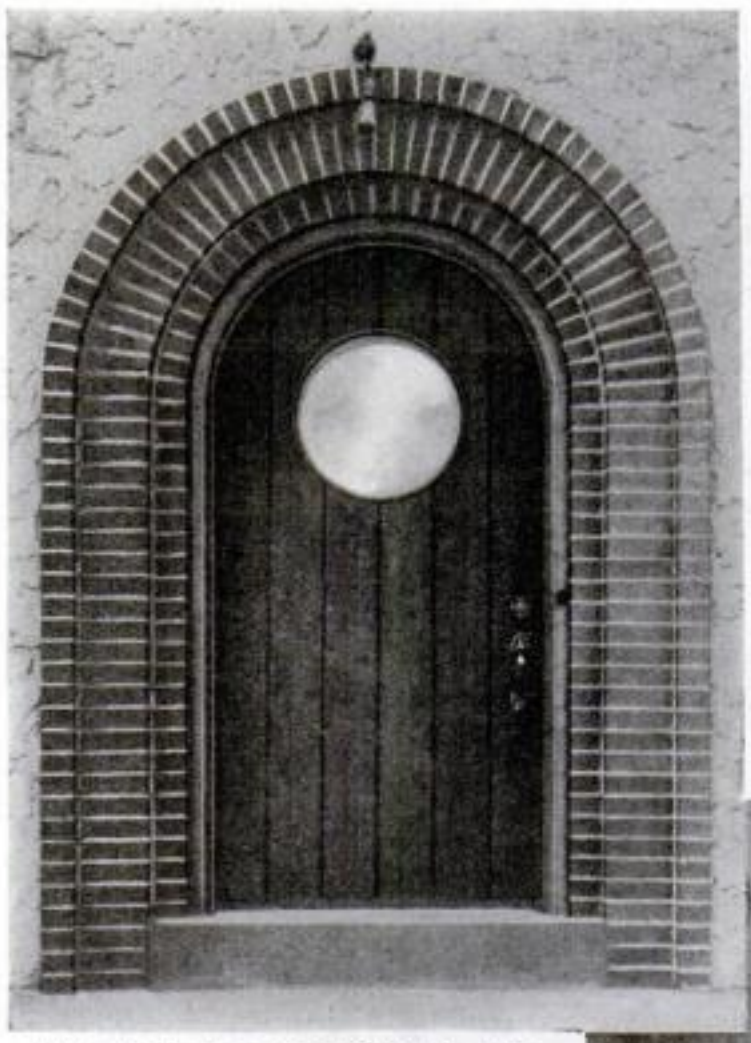
When a door to be refinished is in very bad shape, the old finish should be removed to the bare wood. The refinishing process then is similar to finishing a new door. If the old finish is in reasonably good condition, it is sufficient to clean and sandpaper it thoroughly and apply two coats of spar varnish.

For removing the old finish, when necessary, the amateur painter will find it best to use a commercial paint and varnish remover applied according to the manufacturer's directions. When properly softened, the varnish can be cleaned off with rags or waste and a dull scraper or broad putty knife.

The scraping must be done with care to avoid splintering or damaging the wood. Move the scraper with the grain of the wood and be particularly careful to clean out the corners. Coarse steel wool may be used on panel moldings and irregular surfaces. Wash away all traces of the varnish remover with benzine or gasoline, and sandpaper with the grain, using No. 1 sandpaper, until the wood is smooth and clean looking. Then dust it well.

Once the door is in condition to be refinished, you have a choice of finishes. Personal preference or the architectural style of the house may call for a finish that is well filled, smooth, and glossy; or it may require an antique or weathered appearance. It is most convenient, perhaps, to classify the finishes in respect to the woods of which doors are commonly constructed.

Doors of pine and fir frequently are finished with paint, enamel, or lacquer enamel. Such finishes were described in an article, "How to Enamel a Front Door," in the August, 1928, issue of POPULAR SCIENCE MONTHLY. When, however, they are to be varnished, the following procedure will insure good results.



Front door of a modern Spanish style home. It is finished with stain and varnish to reveal the decorative grain of the wood.

The most generally used and most practical stains for new doors are ready-mixed oil stains (or wood dyes, as sometimes designated). On old doors, from which the original finish has been removed, alcohol or spirit dyes are frequently preferred because of their superior penetrating qualities, but they must be of a type suitable for outdoor use so that they will not quickly fade.

Provided the wood has been well sandpapered and dusted, apply the desired stain with a 2-, 3-, or 4-in. flat paint or varnish brush. Work it well into any grooves and joints and brush it with the grain of the wood.

If an oil stain is used, allow it to set for a few minutes and then wipe it lightly and evenly to remove any excess on the surface. The color may be lightened to some extent by vigorous wiping. Should the color be too light, apply a second coat of stain. Allow the stain to dry thoroughly; overnight is usually sufficient.

A blowtorch is used in giving cypress this striking driftwood finish, known as Japanese sugi.

For the varnishing, use only exterior varnishes made for such service. They are usually called spar varnishes. Some interior varnishes, however, are also called spar, although they are not suitable for outside wear.

Apply the varnish with a flat varnish brush 2 or 3 in. wide. Brush it well into the wood, applying it freely, but avoid sags, runs, or wrinkles. Runs are likely to occur around moldings, under openings, and at corners. After applying the varnish to one side of the door or as large a part as is convenient, wipe the brush on the pot edge to remove all the varnish possible and again brush over the surface, first in one direction and then at right angles, so as to pick up any excess varnish and distribute the coating evenly.

Using a wad of excelsior to wipe surplus paste filler from the surface of an open-grained wood.

Allow at least twenty-four hours for the varnish to dry; then rub it down lightly and evenly with very fine waterproof sandpaper and water or with pumice stone and water on a felt pad. Rub only enough to cut off the dirt nibs and dust. Wash the surface clean with water and wipe it dry.

Apply the second coat in the same way and rub it preparatory to a third coat, if a third coat is necessary. A third coat should be used when a new door is being finished or an old door is being refinished from the bare wood, but two coats are sufficient to renew a varnish finish that was in fairly good condition to begin with. The final coat should not be rubbed unless you wish to have a semidull finish.

Obviously, the (*Continued on page 117*)

C & L 32

This is one of the most popular blow-torches we have ever made. It is more expensive than the 158 because it is made for much harder use. It is designed for the man who uses a blow-torch in his daily business and demands not only excellent performance but rugged ability to stand rough handling. 32 contains the most advanced patented C & L blow-torch improvements. It also has a red handle with the gold stripe. Sure sign of satisfaction.

ARE YOU PARTICULAR ABOUT YOUR TOOLS?

"You bet your life I am," you say. "When I buy a tool it's got to be right and *it's got to stay right.*"

When you buy a Clayton & Lambert torch you're putting a worth-while tool on your workbench. The most exacting blow-torch uses are considered in the manufacture of Clayton & Lamberts. Lasting materials—the strongest available, selected for long, efficient use. Many of the features of design are exclusive and patented Clayton & Lambert improvements—the result of 40 years' experiment and invention. And Clayton & Lambert torches are made by precision workmen. Men who think of tools and look at tools in the same light as you.

For instance—the vaporizing chamber has an exclusive vein system for quicker, hotter heat. That makes the torch function better and saves money on your fuel bills. All fittings are built into the tank by a patented method that prevents their falling in or coming out. There's *absolutely no danger* of an explosion with a Clayton & Lambert torch. Even the most delicate part—the gas orifice—is fool-proof. In the No. 158 the orifice has a guard. Slightly higher priced, No. 32 has a patented design so that you'll never ruin the torch by a careless twist of your wrist. And as you close the valve you automatically clean the orifice.

Things of that sort have made Clayton & Lamberts the largest selling torches in the world. There's satisfaction and pleasure in working with such a fine, capable tool.

You can buy Clayton & Lambert torches at hardware, electrical and automobile accessory stores. Look for the handle—it's red with a gold stripe. But to be sure—look for the trade-mark, too. It pays you to be certain that you're getting a Clayton & Lambert.

C & L 158

This blow-torch is especially made and priced for the man who likes to do odd jobs around the house, or to tinker with mechanical things. It will last a lifetime if it is not abused. The usual retail price is about five dollars. Most hardware, electrical and automobile accessory stores have it—or can get it for you quickly. Look for the red handle with the gold stripe.

CLAYTON & LAMBERT

MANUFACTURING COMPANY

Detroit, Mich.

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A Dresser for Small Homes

Requires Little Space, Is Not Hard to Build, and Has the Style and Grace of a Fine Old Antique

By
WILLIAM W. KLENKE

SOUND, knotty white pine should be used in making a small Welsh dresser like that illustrated so that it will be in strict keeping with original antiques of this type, which are highly prized and valuable.

In finishing the dresser an attempt should be made to imitate the mellow tones of fine old pine furniture. This can best be done by applying one coat of boiled linseed oil followed by a coat of one part walnut oil stain to five parts turpentine. Allow the stain to dry thoroughly and then rub the high parts with fine sandpaper until the wood is almost bare, so as to give the piece a worn effect at those places where wear would naturally become visible in the course of years. Follow this treatment with two thin coats of white shellac and a well-rubbed coat of furniture or floor wax.

All the applied moldings shown in the drawings below are of stock design and can be obtained in most localities, although it is possible to substitute other stock moldings in their places. The drawer pulls should have the finish of dull, antique brass.

The dresser is made in two separate units which, when completed, are screwed together. The instructions for constructing the two parts may be summarized briefly.

Body or base unit. Turn the four legs carefully to the design indicated. Work out the rails to the desired profile and hand dress them thoroughly. Cut all joints and assemble the frame. The bottom shelf must be built in at the same time the project is being glued together.

Construct the drawer and put it in place. Work out the top and fasten it to the frame from the underside by using panel irons or similar fastenings that will allow for expansion and contraction. Apply all moldings.

Shelf unit. Hand dress all the stock. Cut out the profiles of the sides and the toppiece. Cut dado joints in the sides. Carefully fit the shelf, the top, and bottom, and assemble the whole. Fasten the back in place by nailing through into the shelf and the top and bottom pieces.

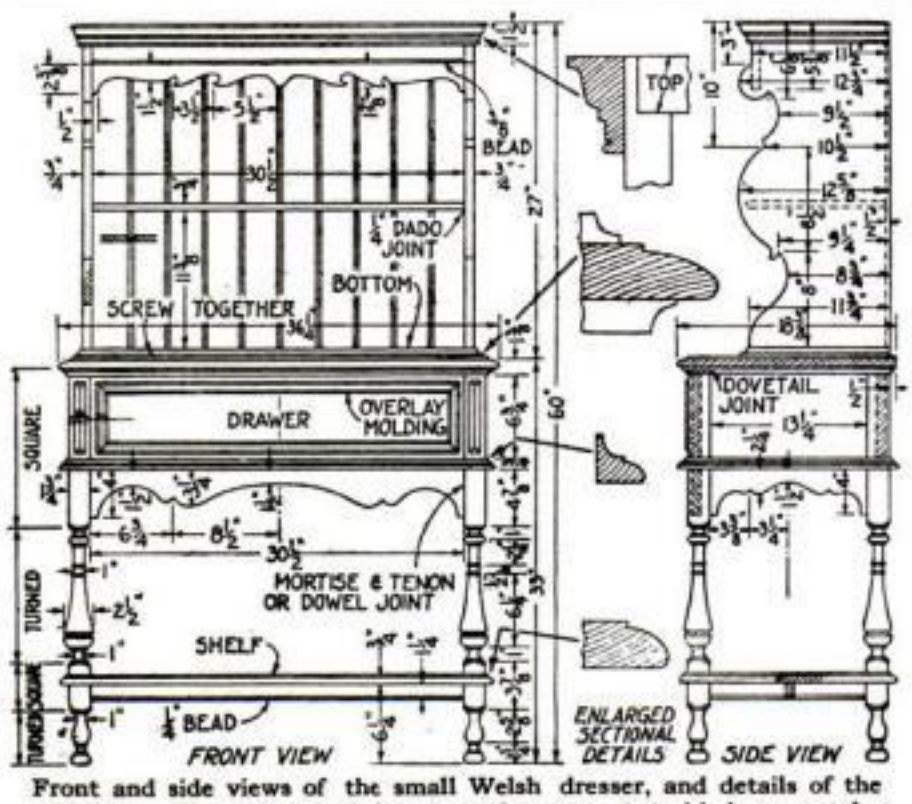
Apply the top molding. Screw the shelf part to the body part from the underside. Fit and fasten the molding at the junction of the two units. Clean all parts thoroughly with sandpaper and finish as previously suggested.

This dresser won first prize in one division of a contest conducted by POPULAR SCIENCE MONTHLY for teachers.

A Lacquered Finish

WHEN a lacquered finish is desired instead of shellac and wax, the following method may be substituted.

Give the wood an antique appearance with greatly thinned brown oak alcohol wood dye or a stain made by dissolving eight tablespoonfuls of air-drying asphaltum varnish in a quart of gasoline. Allow this to dry thoroughly and apply a coat of one part orange-shellac and one part denatured alcohol. Smooth this, when dry, with the finest obtainable sandpaper and rub through the stain to form "high lights" as described by Mr. Klenke. Dust well and apply another coat of three parts orange shellac to one part alcohol. Finish with two coats of clear lacquer and rub the second with FF pumice stone and crude oil. Finally polish the piece.



Front and side views of the small Welsh dresser, and details of the moldings. The upper and lower sections are assembled separately.

FOR his Welsh dresser design, Mr. Klenke was awarded first prize in the advanced woodworking division of a shop problem competition recently conducted by the Educational Department of POPULAR SCIENCE MONTHLY for teachers. The list of prize winners is as follows:

Woodworking. **Elementary: 1—F. W. Megow, Wyncote, Pa.; 2—George Dally, Milwaukee, Wis.; 3—W. A. De Vette, Erie, Pa. Intermediate: 1—Jonathan Bright, Erie, Pa.; 2—Charles A. Sylvester, Pittsburgh, Pa.; 3—George Dally. Advanced: 1—William W. Klenke, Newark, N. J.; 2—Frederick W. Voss, Waukegan, Ill.; 3—Paul N. Wenger, Greenwich, Conn.**

Metalworking. **Elementary: 1—W. A. DeVette; 2—Jerome F. Derwallis, Newport, R. I.; 3—E. W. Manzer, Bronxville, N. Y. Advanced: 1—George Gordon, Jr., Bridgeport, Conn.; 2—Clyde R. Garl, Canton, Ohio; 3—E. C. Youngbluth and John F. Faber, Erie, Pa.**

Electricity. **1—S. L. Coover, Beaver Falls, Pa.; 2—E. A. Rerucha, Wakefield, Mich.; 3—G. Dewey Fenstermacher, Allentown, Pa.**

Many of the designs will appear in forthcoming issues.

How to File Your Hand Saws

Told by Saw Makers Who Are the World's Largest Users of Files

DISSTON files were made first for Disston saw makers. These men must have files that cut fast, cut true, save time and stand up to the job. Files that are sharp! . . . accurate! . . . dependable! . . . lasting! These are the qualities that Disston Steel makes possible in a file and in all cutting tools.

Now, for the benefit of all who work with tools, Disston Files—*for every purpose*—all made from Disston Steel, may be had at good hardware stores.

Ask for "Disston"! Saws, of course; but also Disston *Files*.

Files for the Metal Worker

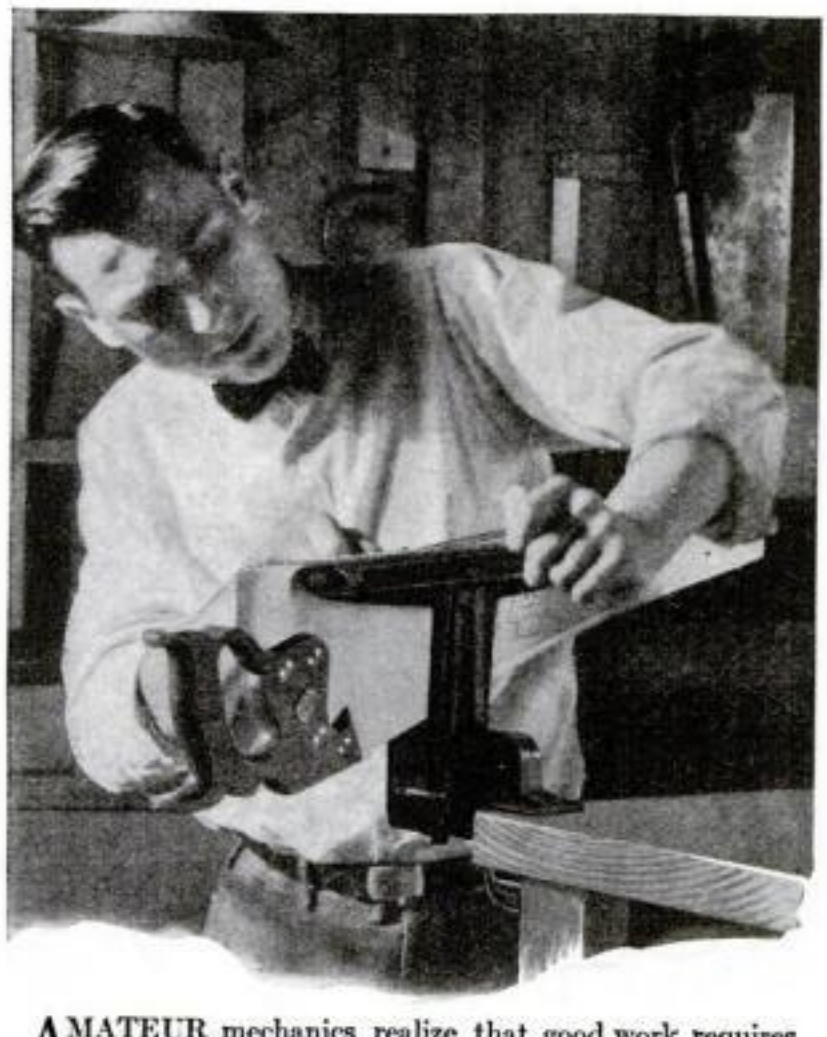
Every kind, size and style. A Disston 8-inch Mill File, bastard cut, is fine for sharpening axes, lawn mowers, garden tools, and general work in the home and shop. Excellent for finishing metal surfaces. 25 cents each.

Hints on Using a Hack Saw

For cutting pipes, bolts, nails, curtain rods, etc. Strain blade tight. Cut on forward stroke. Disston No. 36½ Hack Saw Frame takes 8" to 12" blades. $2.10. Blades, 8", 55c doz.; 10", 65c doz.; 12", 75c doz.

For Finishing Wood Surfaces

For giving a fine finish to your work, removing paint, etc., use a Disston Acme Cabinet Scraper, made of Disston Saw Steel. Made in all needed sizes, 2¼" and 2¾" wide and 5" and 6" long being standard. 25c and up.



AMATEUR mechanics realize that good work requires keeping good tools in perfect condition. "The Disston Saw, Tool and File Book" tells and shows you how to sharpen your hand saws. It answers these questions, so frequently asked:

What tools do I need for filing a hand saw?

A saw file, with handle. The Disston Special Extra-Slim Blunt Saw File is easiest to use. A saw clamp is necessary. The Disston D-3 Filing Guide and Clamp will greatly assist you in filing your saws. If the teeth require setting, use a Disston Triumph Saw Set.

What is meant by "jointing" a saw?

Jointing is leveling the tops of the teeth before filing. Necessary only when teeth are uneven or out of shape, when they should be evened up on top with a Disston mill file or a Disston Hand Saw Jointer, before setting or filing.

How are the teeth to be filed?

Look at a new saw, or at perfect, sharp teeth at wide end of your saw, if it has never been sharpened. Follow these perfect teeth for shape and bevel. On cross-cut saws, start at small end of blade and work toward handile. File every other tooth, then reverse saw and file remaining teeth. Hold file level, at 45° angle to blade. On rip saws, file teeth straight across.

All your saw filing questions are answered in "The Disston Saw, Tool and File Book." Write to us for it.

DISSTON

***Makers of* "THE SAW MOST CARPENTERS USE"**

"The Saw Most Carpenters Use"

The two handiest saws for the home workshop are the 26-inch 8-point for cross-cutting, and the 26-inch 5½-point for ripping. You will need these on almost every job. The popular "D-8" Lightweights cost $3.45.

Handiest of All Small Saws

The Back Saw, with fine teeth and stiff back, enables you to do smooth, accurate cutting of mitres, grooves, etc., for making furniture, picture frames, etc. Disston No. 4, 12" size, 3" under back, 14-point, costs $3.00.

On Your Power Saw Outfit

With a Disston Circular Saw you can do better work. Disston Steel and Temper make a saw cut easier and stay sharp longer. There is a Disston Saw—cross-cut, rip or combination—for your outfit. Made in all sizes.

Every saw user will enjoy reading "The Disston Saw, Tool and File Book," an illustrated manual on the selection, care, and use of tools. It tells how to file and set saws and contains much other helpful information. Sent free. Use the coupon, or write for it.

Henry Disston & Sons, Inc., Philadelphia, U.S.A.
(In Canada, address Henry Disston & Sons, Ltd., Toronto)
Please send me "The Disston Saw, Tool and File Book."

Name and Address.....

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The "Ten Thousandth" Touch

How a Machinist Can Insure Great Accuracy in Using His Micrometers—Methods of Testing Them—Vernier Calipers

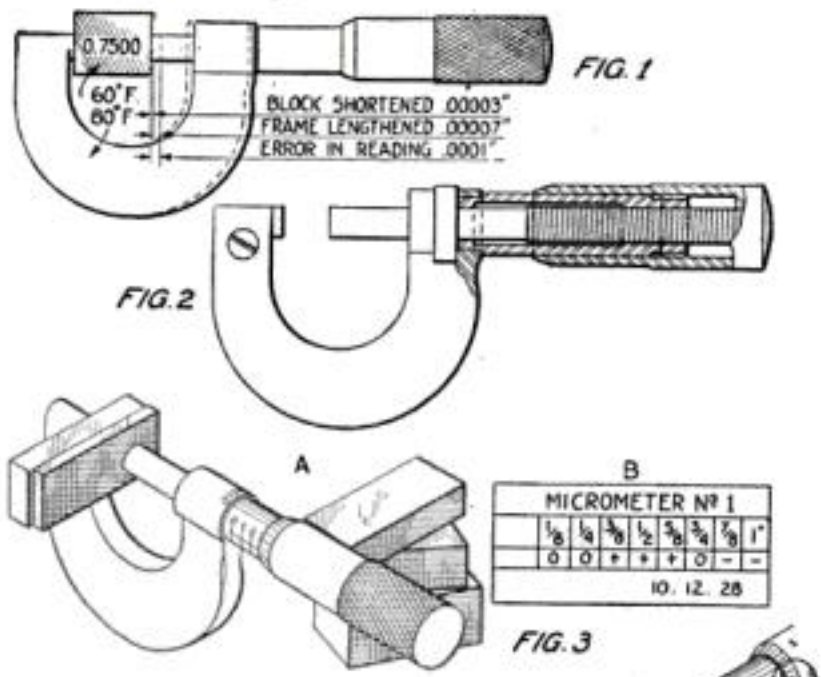
By HENRY SIMON

MEASURING tools manufactured today combine precision and durability to a remarkable degree. Modern mechanics work to limits of accuracy that a generation ago would have been considered so close as to be of service only in the finest of scientific work.

While the instruments with which the present-day machinist measures his work are constructed with a precision that makes it possible to measure almost infinitesimal differences in length, there are so many factors that influence this result that the mere use of a precision tool does not necessarily mean that the work will be just that precise.

Figure 1 shows what startling differences are made by variation in temperature. A toolmaker decides he will check his vernier micrometer with a standard precision gage block, of the kind that has been standardized by the Bureau of Standards by the light wave method and which can be depended upon to be accurate.

The tool room from which he obtained the gage block was a little cold that morning, and the gage block is at a temperature of 60° F. He has been carrying the micrometer in his vest pocket, and it is at a temperature of 80° F. Now the gage block was standardized at 66° F., as are all others, and at that temperature would be precisely ¾ in. long.



Diagrams to illustrate why micrometers require careful testing with gage blocks.

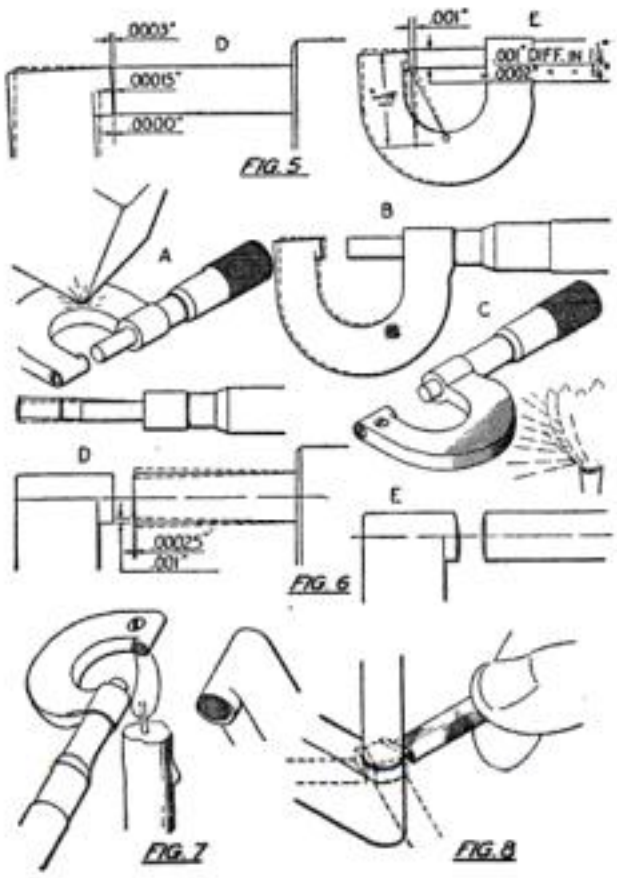
However, the gage is 6° cooler than standard, and, as steel changes in length .000007 in. per inch length for each change of 1° F., the gage block is .00003 in. short. In like manner, the micrometer, which is 14° warmer than standard, has increased in length .00007 in. This, added to the shortening of the gage block, makes .0001 in., which can be read with the vernier. Therefore, if the tool were checked under the conditions named, it might be said that it were one ten thousandth off when, in reality, it was absolutely correct.

If you want to deal in ten thousandths—and that is the reason for the vernier on your micrometer—the way to be sure that it is "right to the scratch" is to check your micrometer periodically by comparison with unquestionable standards. These are available in the shape of precision size blocks, which are guaranteed accurate within less than .00001 in. If your shop does not have a set, you may be able to obtain the use of a set owned by someone else. However, you should bear in mind that your micrometer and the gage blocks must be at the same temperature.

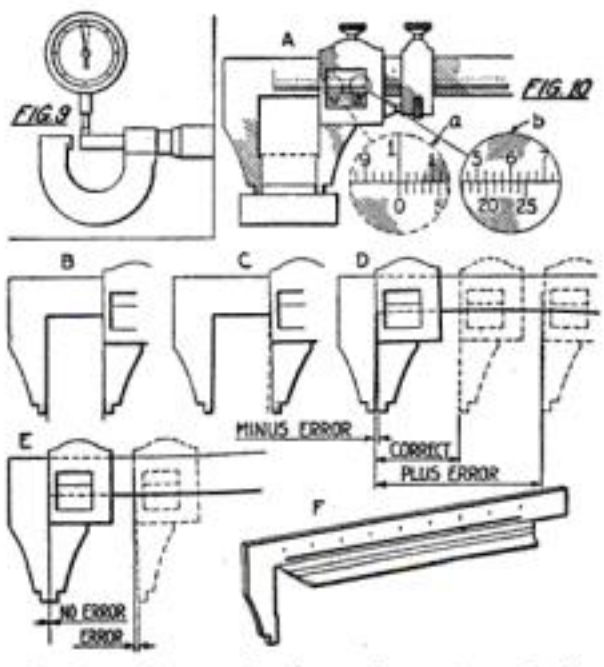
Figure 2 shows why a good micrometer may read zero when it is closed and 1.0000 in. when tested with a 1-in. standard, and yet be inaccurate at some of the intermediate points. The nut makes contact with the spindle for about only one fourth of its length. For this reason it is wise to check the micrometer at intervals, as shown at *A*, Fig. 3, and note down what differences are observed on a card to be kept for reference, as at *B*. This checking should be done with standard gage blocks, and it is well to check at one or two of the intermediate numbers on the barrel, say 8 and 16.

One other formality should be attended to, or else the condition shown in Fig. 4 may exist. Here the same micrometer is giving different readings on three objects, each of which is exactly the same size. The flat end gage at *B* is measured exact size, the round disk at *C* is read undersize, while at *A* a third piece of work, a narrow-faced part, is measured still more undersize. The reason is that the end of the spindle and the anvil are not parallel, as shown in Fig. 5 at *D* and *E*.

There are various ways in which the face of the anvil may get out of parallel with the spindle—ways other than that practiced by the imaginative garage man who discovered his "mike" was also a good C-clamp. It may become peened by an accidental blow, as in Fig. 6 at *A*, or from local pressure from being clamped too tightly in a vise as at *B;* or it may have been accidently overheated as at *C*. Likewise, the spindle may have become sprung a trifling amount as at *D*, yet enough to cause trouble. (*Continued on page 115*)



Mishaps which may throw anvil and spindle out of parallel; how to test their parallelism.



Testing the truth of a micrometer spindle; points to observe in checking vernier calipers.

They need Starrett ACCURACY *and* DEPENDABILITY *too*

This chap is using a Starrett No. 99F Transit, an exceedingly simple, practical transit anyone can use at a very moderate price.

The same quality of materials and workmanship that has made Starrett Tools the universal choice of expert machinists and carpenters has made Starrett Tapes and Transits and Levels equally popular favorites.

Your tool dealer has a Starrett Tape, Transit or Level that meets your exact requirements. Ask to see them. Let us send you a free copy of Starrett Catalog No. 24 "W".

THE L. S. STARRETT CO.
World's Greatest Toolmakers
Mauufacturers of Hacksaws Unexcelled
Steel Tapes—Standard for Accuracy
ATHOL, MASS., U.S.A.

The Starrett No. 530 Steel Tape in handsome black imitation leather case. Well made, strong, surprisingly low in price.

Wood leveling rod and target.

Starrett No. 132 Bench Level with Double Plumbs.

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Use Starrett Tools

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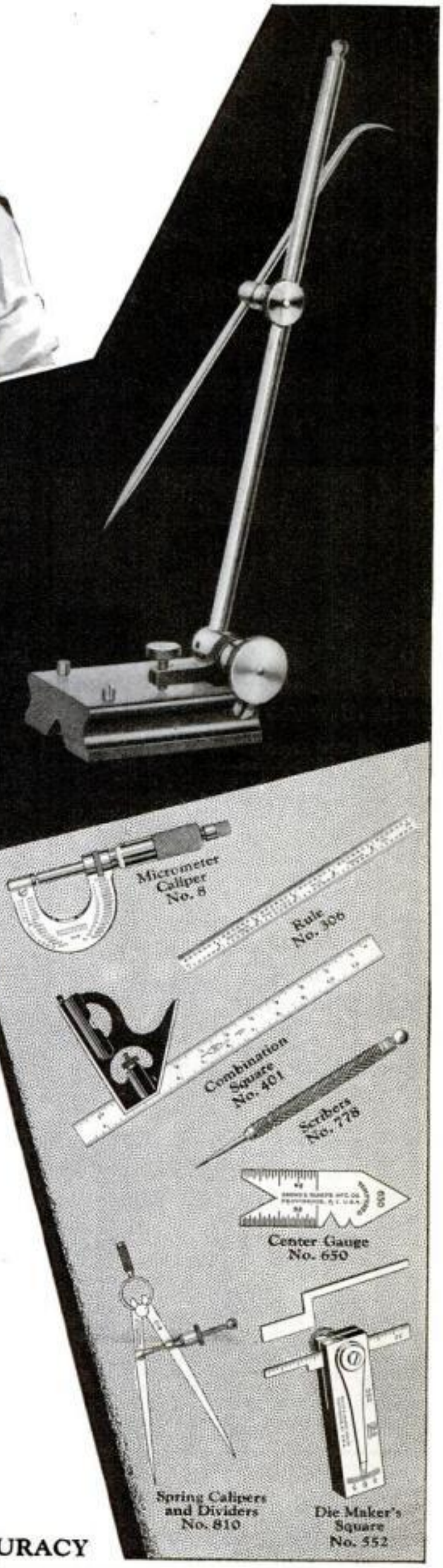
Where Only the Best Tools Can Stand the Pace

The manufacturer, the foreman and the machinist are the ones who justify the extreme care taken in making Brown & Sharpe Tools.

They know that modern methods of manufacturing lay so much stress upon speed and accuracy that only tools of the high quality which Brown & Sharpe products are known to possess can stand the pace.

Visit your hardware dealer or send us a postcard and get a free copy of our Small Tool Catalog describing over 2300 tools (including Surface Gauge No. 621 illustrated above.)

Address Dept. P.S., Brown & Sharpe Mfg. Co., Providence, R. I., U. S. A.



WORLD'S STANDARD OF ACCURACY

BROWN & SHARPE TOOLS

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Drilling Holes in Glass

Small Ones Are Bored with a Sharpened File, Large Ones with a Tube

By E. E. ERICSON

Fig. 1. How the point of a triangular file is ground for drilling glass. Take care not to draw the temper.

Fig. 2. The way a file is held in a brace and used to drill either window or plate glass. Note ring of putty to retain the turpentine.

Fig. 3. When the tube method of drilling—or, more properly, grinding—is to be used, it is necessary to construct a wooden guide, as illustrated below.

"WHERE can I go to get some holes drilled in a piece of glass?" I was asked recently by a neighbor who uses his home workshop as a place to forget business worries.

"I am not sure that I know," was my reply, "but why don't you bore them yourself?"

My neighbor was one of the many who consider working with glass, and particularly drilling holes in it, a complete mystery. The explanation I gave him of the process of boring holes was essentially the following.

For small holes in either window glass or plate glass, a triangular saw file makes an acceptable drill. Grind the point to make three surfaces corresponding to the sides of the file as shown in Fig. 1. It is better to use a grinding wheel that runs in water or oil in order to be sure not to heat the file, but if a dry wheel must be used, apply the file with very light pressure and dip the tip in water often. If the temper is drawn, the file is useless.

To prepare the surface of the glass for drilling, mark the place for the hole by a scratching action of the point of the file. Then make a circular container around this mark, using putty or other plastic substance. Leave the glass exposed in the center and fill the little bowl with turpentine.

The drilling is done with the file in a brace as shown in Fig. 2. A breast drill or a hand drill can be used for greater speed. Use light pressure and reverse the glass as soon as the point goes through.

The process of drilling in this manner is not rapid but, unless a large number of holes are to be made, it will prove satisfactory. The size of the file selected will, of course, determine the maximum size hole that can be drilled in this way.

For larger holes effective work can be done by using a brass tube. A suitable piece of tubing often can be had for the asking at a plumbing shop. Some such device as that shown in Figs. 3 and 5 is necessary for holding the tubing in place and perpendicular to the glass. It consists of a baseboard upon which the glass rests, a small block to serve as a spacer, and a two-by- (*Continued on page 114*)

Fig. 4. Shallow notches are filed in the end of the brass tube to help distribute the abrasive.

Why it is so *easy* to learn to type on CORONA

"OUR little boy has loved Corona ever since he was big enough to notice the letters."

"I learned to use Corona when I was sixty-eight. It is much easier than writing by hand."

Scores of letters like the above have come to us. They show how easy it is to use Corona. If children too young to hold a pencil can use Corona, anybody can. If old people whose handwriting has grown shaky can use Corona, anybody can.

To say that it is easy to operate Corona is understating the facts. It is *astonishingly* easy. Beginners, after reading a helpful little book that is given free with every Corona, can learn the fundamentals in just a few hours.

In the very beginning, Corona was designed with the idea that it would be used by people who had no typewriter experience.

That was twenty years ago. Corona is still built with the beginner in mind. All the needs of the amateur typist have been studied by Corona engineers. Every year we have improved Corona—made it more convenient. Here are a few advantages which make it the easiest typewriter in the world to operate:

Adjustable Key Action—The touch can be made light or heavy to suit your requirements.

Adjustable Paper Guide—Insures uniform margin on all pages of a manuscript.

Back Spacer and Margin Release—These are conveniently located on the keyboard.

Carriage Return Lever—This is made extra large and convenient. It enables you to perform the two operations of spacing and returning the carriage to the starting point with one sweep of your hand.

Extreme Visibility—Holds paper at correct reading angle.

Key Spacing—Same as on office typewriters.

Standard Keyboard—Four rows of keys, exactly like a big office machine.

Corona has many, many other features. There is not room on this page to describe them all. Other portable typewriters have some of these features. But no other portable has *all* of them.

In making Corona easy for beginners to operate, we accomplished another result—an unforeseen result. The very features which enable beginners to write more easily, enable accomplished typists to *greatly increase their speed.*

You owe it to yourself to drop into a store where typewriters are sold and see Corona. The minute you lay eyes on it you will realize why a million people use it—why Roosevelt took one to Africa—why 30,000 Coronas were used in the World War—why more novelists, more newspaper men, more business men, more schools and colleges use Corona than all other portables put together.

For a small down payment you can take a beautiful new Corona home with you today. Don't neglect this opportunity. Don't let another day pass without doing something about it. Know *now* the joy of owning a sturdy, speedy, smooth-operating Corona — the World's Champion Portable.

An interesting illustrated booklet called "Corona Typewriters" which describes Corona in detail, and contains beautiful illustrations of the new color models, will be sent you upon request. No obligation. Simply mail the coupon below.

CORONA IS THE WORLD'S CHAMPION PORTABLE ON 8 EXCLUSIVE POINTS

1. STRENGTH: *Strongest frame of any portable typewriter — solid one-piece aluminum, rigidly braced.*
2. SIMPLICITY: *Fewer parts than any other standard-keyboard typewriter.*
3. COMPLETENESS: *More big-machine features than any other portable typewriter.*
4. EASY TO LEARN: *Corona design is the result of 20 years' study of the needs of beginners.*
5. WAR SERVICE: *An unequalled record for durability as the official portable of the Allied Armies.*
6. POPULARITY: *As many Coronas have been sold as all other portables combined.*
7. DURABILITY: *Coronas purchased 20 years ago are still giving satisfactory service.*
8. BEAUTY: *Graceful in line; exquisitely finished in every detail.*

CORONA

The PORTABLE TYPEWRITER

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51 Madison Ave., New York, N. Y.
Please send me the free booklet, "Corona Typewriters."

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How I Built a Portable Workbench for Use in a Small Apartment

3543-1

By PHILIP H. MILLER

HERE is how a "home workshopper" overcame the obstacle of having no place to work in a small modern apartment.

In the foyer adjoining the kitchen was a clothes closet. It wasn't very large, but why couldn't I build a small cabinet and store it in one end of the closet—a combination bench and tool chest?

As it was not my intention to make the cabinet a show piece, I used for lumber old cases and crates that I found in the cellar of a stationery and toy store on the corner. The only materials purchased were four hinges 2½ in. wide, four handles for drawers, four casters, five cents' worth of 2½-in. round-headed screws, and ½ lb. sixpenny nails, costing altogether sixty-nine cents.

The apartment-size cabinet workbench ready for use (above) and raised on casters (at left) so that it can be rolled away and stored in a closet.

The tools used were a hammer, crosscut and rip saws, try-square, plane, ruler, screw driver, and drill.

First I cut the two sides ¾ by 11½ by 30 in. and nailed a piece ¾ by 1¾ by 19 in. across the front end of these at the top, and a piece ¾ by 3½ by 19 in. across the bottom and extending ¾ in. lower than the ends of the sides—to allow for the thickness of the bottom. Two vertical pieces ¾ by 1¾ by 25½ in. were then nailed to the sides to complete the frame of the front.

The bottom, ¾ by 11½ by 19 in., was nailed under the sides, the ends of it being flush with the sides. The back, ½ by 19 by 30¾ in., was then nailed on. Before I attached slides for the drawers, I computed the depth of the drawers by what I intended to keep in each and built them accordingly.

Mr. Miller's bench aided him in making this dresser and many other pieces of furniture.

The top I made of ¾-in. stock. One piece 15 by 20½ in. was cut to run from front to back, extending 2½ in. over the front and ¾ in. over each side. The other section or layer of the top I made 15 by 19 in., thereby allowing ¾ in. on each end for a piece of quarter-round molding 15 in. long. I nailed the first board to the sides, front, and back, and then inverted the skeleton of the cabinet on the other board, the grain of which runs at right angles to the grain of the first one; and, after allowing ¾ in. on each side for the molding, I screwed the first board to the second. When the cabinet was right end up, I had a smooth top without visible screws or nails. I then nailed on the molding at the ends of the top with 1-in. brads.

Now for the most interesting part—the method of mounting the casters on pieces of wood 3½ by 12½ in. that are fastened to the bottom of the bench with hinges set ¾ in. from the ends. The width of these pieces is of great importance; it has to be exactly 3½ in. so that when the cabinet is tilted each will flip outward of its own momentum and not hit the floor. If they were too wide, the weight of the cabinet would fall on the hinges and, of course, break them very soon. At this width, the weight rests on the corner of the cabinet, allowing a needed ¼ in. before the hinges on the tilted side are opened to capacity.

The casters are ball bearing and have flat tops or screw plates 1¼ by 1¾ in. with four screw holes. They are set 1 in. from each side (*Continued on page 118*)

STOP *that* CHATTERING

No slipping, no chattering with the new Millers Falls Planes. Instead a smooth firm stroke that means finer work with less effort, that adds to the satisfaction and pleasure of a job well done, that removes completely the constant irritation of a chattering plane.

This age-old cause of plane trouble was tackled scientifically by Millers Falls engineers. Smoother cutting depends on the pressure with which the blade is held at the correct cutting angle. So a 3-point bearing of the lever cap was added. This bearing keeps the cutter flat the entire length of the seat. It makes possible a hair breadth adjustment that holds and completely overcomes chatter.

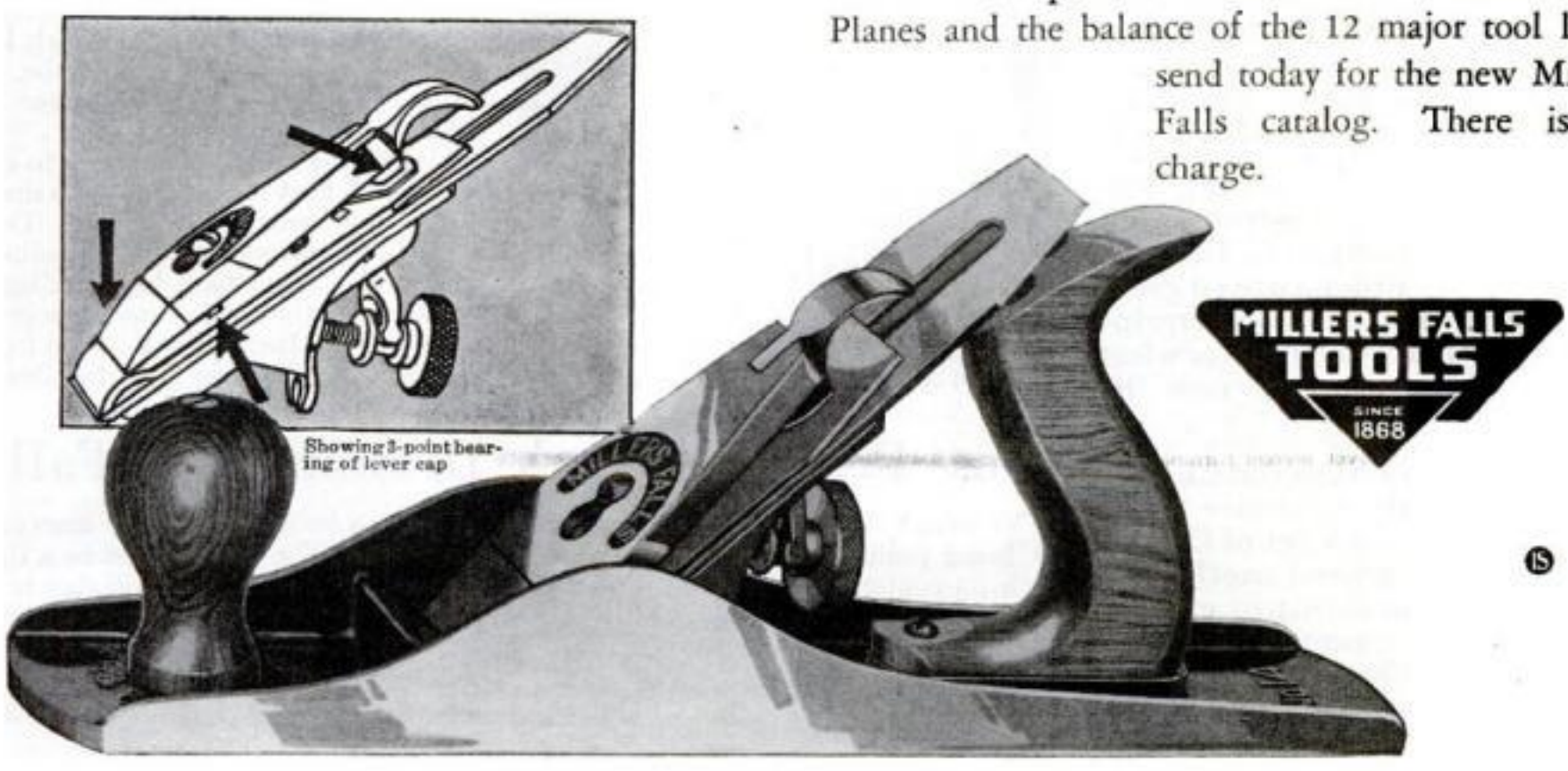
Another New Feature . . . improved cutting edge

The improved Millers Falls cutting edge is the result of years of experience with fine tool steels. A new process of tempering the cutters electrically, gives the edge greater uniformity and longer life. Think what this means—more time spent in productive work, less time spent in sharpening and reconditioning. And how much easier the work will be with these new planes.

The new line of Millers Falls Planes covers every plane need. Sizes in bench planes from 7 inches to 24 inches, smooth and corrugated bottoms. 21 models of block planes.

But don't take our word alone. Test out one of these improved planes. Then note the difference. Sold by leading hardware dealers everywhere.

For more complete information on the Millers Falls Planes and the balance of the 12 major tool lines, send today for the new Millers Falls catalog. There is no charge.



MILLERS FALLS COMPANY

NEW YORK: 28 Warren St. **MILLERS FALLS, MASS.** CHICAGO: 9 So. Clinton St.

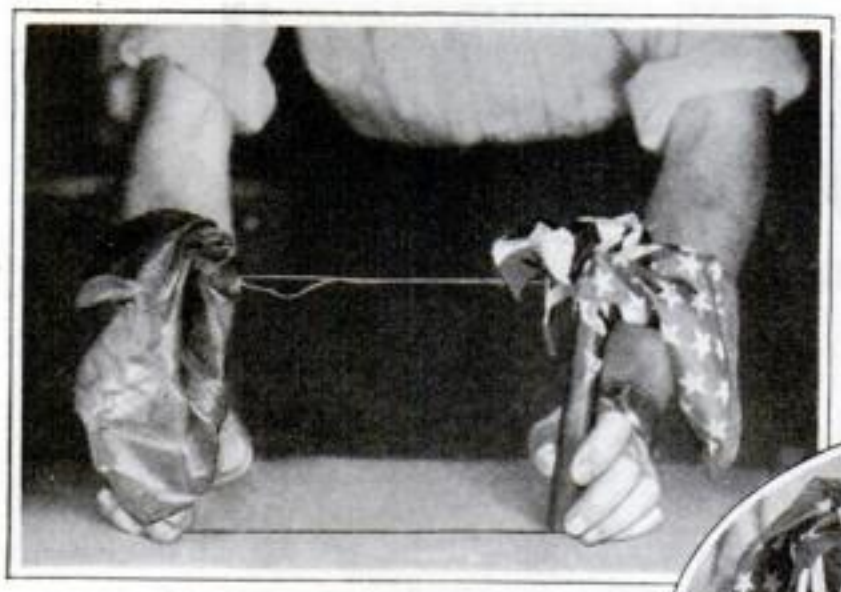
This seal on an advertisement in POPULAR SCIENCE MONTHLY signifies the approval of the INSTITUTE OF STANDARDS. See page 8.

These Handkerchiefs Can Fly

They Pass Magically Through the Air from One Test Tube to Another—An Easy Trick for Amateurs

35144

By GEORGE S. GREENE



Silk handkerchief and flag ready to change places. The thread, which is in one piece, is invisible at a short distance.

Now they have changed places. The extra thread hangs below and can be discarded.

IN PERFORMING the trick of the flying handkerchiefs, the amateur entertainer places two small silk handkerchiefs of different colors—or a handkerchief and a flag—in glass test tubes. While he is holding one tube in each hand, the handkerchiefs suddenly change places, each flying through the air.

Suitable test tubes usually can be purchased at a drug store. Each is prepared by placing the closed end in a gas flame until the glass reaches the fusing point. A glass rod is applied to the tube and drawn away in such a manner that when it is broken off a hole will be left in the bottom of the tube. The rough edge is softened by reheating.

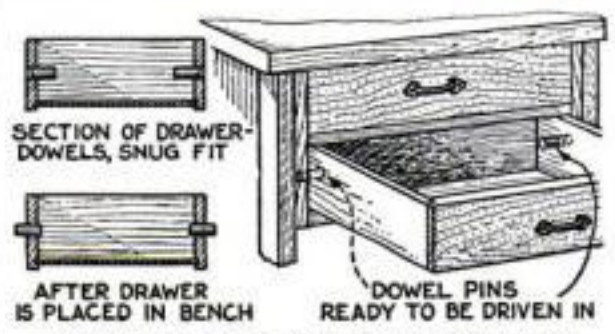
A small hole is formed in the test tube with the aid of a Bunsen burner and a glass rod

A loop is made in each end of a black thread and passed up through the hole in the bottom of a tube. The thread is drawn out of the top and each loop is carried over to the opposite tube, where it encircles the handkerchief—or flag—that is stuffed into the tube.

When the handkerchiefs are to change places, all that is necessary is to draw the tubes apart gently but quickly. This will cause the threads to pull the silks from each tube. In a flash the handkerchiefs fly through the air and enter the opposite tubes. Then they are withdrawn from the tubes and pulled free from the thread.

Pins Prevent Bench Drawer from Falling

TO PREVENT a bench drawer from being pulled out too far and falling with its contents to the floor, dowel-pin stops can be inserted in the drawer sides as shown. The dowels must be a tight fit in the holes so that they will stay in place. If it is necessary to remove the drawer entirely at any time, the dowels can be retracted without difficulty by using pliers or pincers.—G. A. LUERS.

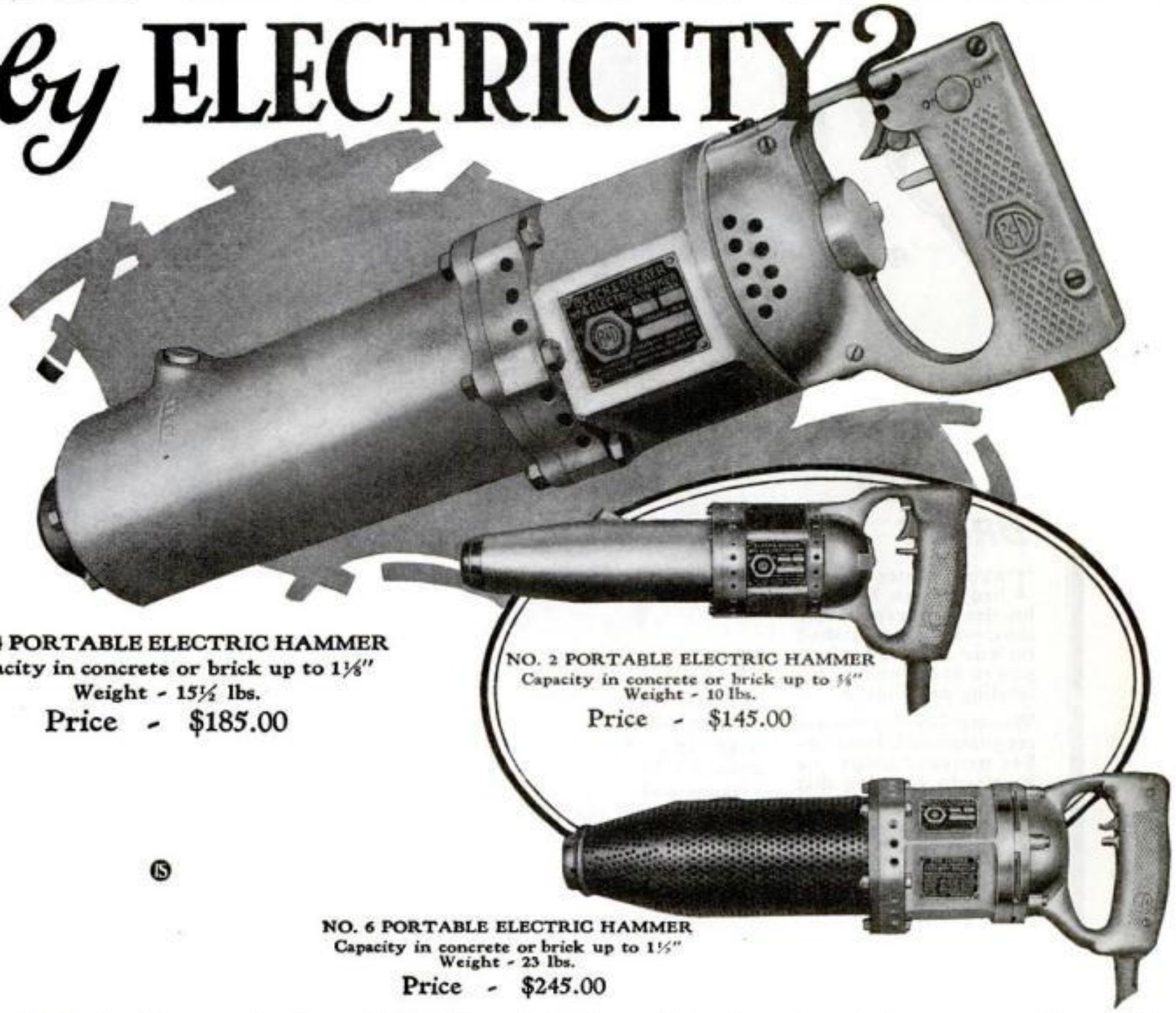


How short dowel pins are inserted in the sides of a bench drawer to serve as stops

---

A SUBSTITUTE for a garden hose washer can be made by removing the cork insert from the discarded cap of a soft drink bottle. With a sharp knife or a punch, cut a hole in the center equal to the inside diameter of the hose.—W. J. RAKEL.

ARE YOU HAMMERING *by* ELECTRICITY?



NO. 4 PORTABLE ELECTRIC HAMMER
Capacity in concrete or brick up to 1⅛"
Weight - 15½ lbs.
Price - $185.00

NO. 2 PORTABLE ELECTRIC HAMMER
Capacity in concrete or brick up to ¾"
Weight - 10 lbs.
Price - $145.00

NO. 6 PORTABLE ELECTRIC HAMMER
Capacity in concrete or brick up to 1½"
Weight - 23 lbs.
Price - $245.00

THIS is the method used in the majority of industries today, regardless of their size. There is no industry so small that "hand hammering" methods will suffice when electric tools are available which will hammer at the rate of from 2,300 to 3,300 blows per minute.

Black & Decker Portable Electric Hammers are manufactured in three sizes with a range from ¼ to 1½ inches in concrete or brick. They can be plugged into any electric socket, making them instantly available. A complete line of star drills, diamond point drills, chisels, seam tools etc., are manufactured for these Hammers, doubling their usefulness.

If you have holes to drill in concrete or brick it will pay you to investigate these powerful, labor saving tools.

Write for our new 8 page Hammer Booklet - also for details regarding our Time Payment Plan.

The BLACK & DECKER MFG. CO.
Towson, Maryland

Gentlemen:

I am interested in your Portable Electric Hammers and will be glad to have further information regarding them.

NAME_____

ADDRESS_____

Renewing Floors Overnight

Varnishes That Dry in Four Hours Make Feat Possible—Enamels for Speedy Work

By BRUCE BRIGHTON

Floors and other woodwork dry overnight when finished with the remarkable new four-hour types of clear varnish, varnish stain, or colored enamel.

VARNISHES and enamels that dry in four hours are the latest development in painting materials. With them you can refinish a floor or other woodwork in the evening and use it the next morning or you can apply one coat in the morning and a second in the afternoon.

These amazing new finishes can be obtained at all up-to-date paint stores in the larger cities, and it will not be long before they will be available everywhere.

As they undoubtedly mark another great step forward in finishing materials, especially from the standpoint of the home owner and amateur painter, a word about their manufacture will not be amiss. They are not merely old-line varnishes and enamels with the drying forced by driers to the impairment of their durability, but an entirely different product, made possible through the use of a new form of synthetic resin. This is produced from formaldehyde and phenol and is closely allied to bakelite. It is used in making the four-hour varnishes in place of fossilized varnish gums. After being incorporated with linseed oil, china wood oil, and other materials in accordance with the formula of the particular varnish being made, it is cooked over varnish fires of the standard type. The enamels, of course, are a combination of four-hour drying varnish with the necessary pigments and coloring.

Let us compare these new quick-drying materials with ordinary varnishes and enamels. Which is preferable is entirely a matter of whether or not quickness of drying is of importance. If there is ample time for drying, there is no reason for using the new type materials. In most homes, however, quick drying is a great convenience, if not of extreme importance. This is true where there are children in the household, especially in the varnishing of floors, from which it is next to impossible to keep the little folks until the varnish has dried.

Even with varnishes that normally dry overnight, the weather and the temperature of the room have so much to do with their drying that often they are still tacky or sticky the next day; and sometimes under unusually unfavorable conditions, it is at least forty-eight hours before the finish has become thoroughly hardened. With the four-hour drying materials there is never the least question about the finish drying overnight.

As to appearance, there is no difference between the finish produced by the new and old materials. The four-hour materials also are quite as easily applied as other varnishes and enamels.

NOW let us compare the four-hour finishes with the cellulose brushing lacquers which came in with almost startling suddenness a little more than two years ago and have since enjoyed great popularity. It is not likely that four-hour varnishes and enamels will be used to any great extent in the field in which brushing lacquers have been almost exclusively used up to this time; their field is one in which the brushing lacquers have never been extensively used. Lacquer has been used largely for finishing unpainted novelty furniture, such as magazine racks, tilt top tables, and the like, and for refinishing chairs and other small pieces of furniture about the house. For such work it is seemingly best adapted. There is a very definite advantage in being able to go right over the surface with a second coat almost immediately after finishing the first coat and also in applying the trimming colors and finishing the piece at one time. There is a fascination *(Continued on page 113)*

Blueprints for Your Home Workshop

OUR blueprints can be obtained for 25 cents a sheet. In some cases there are two or three sheets to one subject. The blueprints are complete in themselves, but if you wish the corresponding back issue of the magazine in which the project was described in detail, it can be had for 25 cents additional so long as copies are available. Other subjects besides those below are to be had; send a stamped envelope for the complete list.

Popular Science Monthly,
250 Fourth Avenue, New York

Send me the blueprint, or blueprints, I have underlined below, for which I inclose.....dollars.....cents.

No.	*Title*	*Described in Issues of*		*Price*
2.	Smoking Cabinet	*Mar.,	'22	25c
15.	Workshop Bench	*Jan.,	'23	25c
27.	Kitchen-Cabinet Table	Oct.,	'23	25c
30.	Tool Cabinet, etc.	*Jan.,	'24	25c
31.	Sewing Cabinets	Feb.,	'24	25c
37.	Simplified Bookcase	Dec.,	'24	25c
43.	Four-Tube Receiver (battery operated)	*July,	'25	25c
44-45.	Pirate Ship Model	*Feb.,	'26	50c
46-47.	Galleon Ship Model	May,	'26	50c
48.	Sailing Yacht Model	*July,	'26	25c
50.	Airplane Model (Rise-off-ground tractor, 36-in.)	*Sept.,	'26	25c
51-52-53.	Clipper Model, *Sovereign of the Seas*	*Oct.,	'26	75c
54.	Five-Tube Radio Set	*Oct.,	'26	25c
55.	Five-Tube Set—Details	*Oct.,	'26	25c
56.	Bird and Animal Toys	Dec.,	'26	25c
57-58-59.	*Constitution* Ship Model ("Old Ironsides")	*Jan.,	'27	75c
60.	Welsh Dresser	Mar.,	'27	25c
61-62.	Viking Ship Model	Apr.,	'27	50c
63-64.	Toy Motor Boat, 29 in. long hull	May,	'27	50c
65.	Six Simple Block Puzzles	June,	'27	25c
66.	Ship-Model Weather Vane	Aug.,	'27	25c
67.	Toy Model of Lindbergh's New York-to-Paris Plane	Aug.,	'27	25c
68.	Magazine-Rack Table and Book-Trough Table	Sept.,	'27	25c
69.	Flying Model (3-ft.) of Lindbergh's Monoplane	*Oct.,	'27	25c
70.	Console Radio Cabinet	Nov.,	'27	25c
71.	Console Cabinet—Details	Nov.,	'27	25c
72.	Doll's House	*Dec.,	'27	25c
73.	Doll's House Furniture	*Dec.,	'27	25c
74-75-76.	*Santa Maria* Ship Model, 18 in. long hull	*Dec.,	'27	75c
77.	Simple Pier Cabinet and Decorative Wall Shelves	Jan.,	'28	25c
78.	Simple Treasure Chests	Feb.,	'28	25c
79.	Electric Radio Set	Feb.,	'28	25c
80.	High Power Unit for Electric Radio Set	Mar.,	'28	25c
81.	Low Power Unit for Electric Radio Set	*Apr.,	'28	25c
82.	Simple Single-Stick Airplane Model (30-in.)	Mar.,	'28	25c
83-84-85.	*Mayflower* Model	Apr.,	'28	75c
86.	Racing Airplane Model (35-in. twin-pusher type)	May,	'28	25c
87.	Seaplane Model (30-in.)	June,	'28	25c
88.	Simple Modernistic Stand; Modernistic Bookcase	Aug.,	'28	25c
89-90.	*Bremen* Scale Flying Model (3-ft.)	Aug.,	'28	50c
91.	Modern Folding Screens	Sept.,	'28	25c
92.	Simple Baltimore Clipper Ship Model (8 in. long)	Sept.,	'28	25c
93.	Three Modern Lamps	Oct.,	'28	25c
94-95-96.	Mississippi Steamboat Model	Nov.,	'28	75c
97.	Modern Electric Radio Set in One-Tube Form	Nov.,	'28	25c
98.	Modern Electric Radio Set in Two-Tube Form	Dec.,	'28	25c
99.	Modern Electric Radio Set in Four-Tube Form	Jan.,	'29	25c
100.	Modernistic Book Ends, Book Shelf, Low Stand	Dec.,	'28	25c
101.	Toy Fire Engine, Sprinkler, Truck, Tractor	Dec.,	'28	25c
102.	Morris Seaplane Model	Mar.,	'29	25c
103.	One-Tube Battery Radio Set (Old No. 41 revised to	Mar.,	'29)	25c
104.	Tractor Airplane Model	May,	29	25c

*Magazine only out of print.

Name.....
(Please print name and address very clearly)

Street.....

City and State.....

Ⓑ This seal on an advertisement in POPULAR SCIENCE MONTHLY signifies the approval of the INSTITUTE OF STANDARDS. See page 8.

Are You Really Well Informed?

Test Yourself with this Famous Questionnaire!

EVERYBODY is talking about the famous "Popular Science Questionnaire." In the panel is the list of questions of which the Questionnaire is composed. How many of them can *you* answer?

These questions were prepared, after a great deal of thought, by a group of eminent scientists. Their test has become famous throughout the country as the "Popular Science Questionnaire."

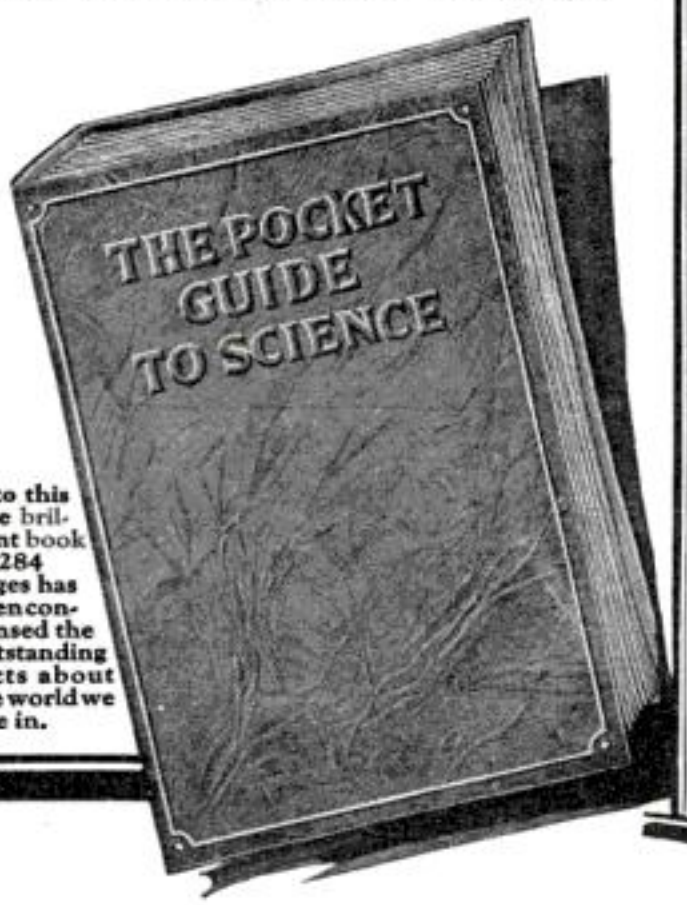
Like an Old-fashioned Examination

May we ask you to make this test carefully, reading the questions slowly and giving thought to each one? When you cannot answer one satisfactorily to yourself, put a zero (0) beside it.

On the other hand, give yourself credit of four (4) for each satisfactory answer. Then when you are through, see how near you have come to making a mark of 100.

This is like an old-fashioned examination, but you will find it fascinating. The questions all have to do with the wonders of the world we live in. All can be given quick and straightforward answers by any person of education.

All of the questions in the famous "Popular Science Questionnaire" and many hundreds of others, have now been answered, for the first time, in one book—THE POCKET GUIDE TO SCIENCE.



Into this one brilliant book of 284 pages has been condensed the outstanding facts about the world we live in.

All that you probably ever will want to know about science is told in this one 284-page book that will fit in your pocket or grace a library table. Curiosity-satisfying facts about the world we live in are made instantly available to you in simple question-and-answer form in THE POCKET GUIDE TO SCIENCE.

You are assured of the accuracy of the answers in THE POCKET GUIDE TO SCIENCE because it has been edited by Dr. E. E. Free, who has remarkable genius for condensing the known facts about scientific questions into easily remembered paragraphs.

The POPULAR SCIENCE QUESTIONNAIRE

Test Yourself Now

1. Why does radium continue to give out heat for thousands of years?
2. Are the stars solid like the earth?
3. How was the earth formed?
4. Why is glass transparent?
5. How do we know that the earth is slowly shrinking?
6. What is an electric current?
7. How was petroleum formed?
8. Do electrons really move through wire when an electric current is flowing through it?
9. What physical changes in your body are produced by fear?
10. How do muscles exert power?
11. What are X-rays?
12. Can we see atoms with a microscope?
13. Why does heat expand things and cold contract them?
14. Why does the moon appear to change its shape from time to time?
15. What is the brain made of?
16. Why is it possible that the inside of the earth is growing hotter instead of colder?
17. Why is frost more likely on a clear night than on a cloudy one?
18. Does thinking use up the thinker's energy?
19. Which travels faster, electricity or light?
20. What simple test will distinguish wool from cotton?
21. What makes the noise of thunder?
22. Why would men ultimately suffocate if all the green plants were killed?
23. Does the boiling of water remove the impurities in it?
24. How do the living cells of the body get the energy with which to do their work?
25. How is the speed of light measured?

TOTAL PERCENTAGE.....

SPECIAL OFFER

THE POCKET GUIDE TO SCIENCE is not for sale. It is offered to you without one penny extra cost, with a 14 months' subscription to POPULAR SCIENCE MONTHLY.

POPULAR SCIENCE MONTHLY "carries on" from where THE POCKET GUIDE TO SCIENCE leaves off. THE POCKET GUIDE gives you all that the scientists have discovered up to right now—POPULAR SCIENCE MONTHLY will give you all the important, interesting and new discoveries of science for the next 14 months.

It takes over 300 articles and pictures every month to tell the readers of POPULAR SCIENCE MONTHLY all that has happened in the scientific, radio, mechanical and automotive fields.

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THE POCKET GUIDE TO SCIENCE is bound in beautiful flexible fabrikoid. We will stamp your name in 22-carat gold on the cover of THE POCKET GUIDE at no extra cost to you if you use the coupon below immediately.

We extend to you the Special Offer of a 14 months' subscription to POPULAR SCIENCE MONTHLY (regular price by the month would be $3.50) with THE POCKET GUIDE TO SCIENCE —all for $2.95, plus the few cents' postage. If you are already a subscriber to POPULAR SCIENCE we will extend your subscription 14 months if you accept this offer.

Send No Money

Send no money, just the coupon. If within 10 days after you receive the book and magazine you decide that you are not satisfied in every particular, you may return them, and your entire payment will be refunded promptly and without question. Could any offer be fairer?

POPULAR SCIENCE MONTHLY 3-29
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I accept your offer of THE POCKET GUIDE TO SCIENCE and a 14 months' subscription to POPULAR SCIENCE MONTHLY. I will pay the postman $2.95, plus the few cents' postage when he delivers the POCKET GUIDE and the first issue of POPULAR SCIENCE MONTHLY. If the book and magazine are not fully satisfactory to me I will return them within 10 days and you are to promptly refund my full payment. Please stamp my name in gold.

Name.....

Address.....

City..... *State*.....

In using Coupon please PRINT Your Name

Modernistic Smoking Stand

By HERMAN HJORTH

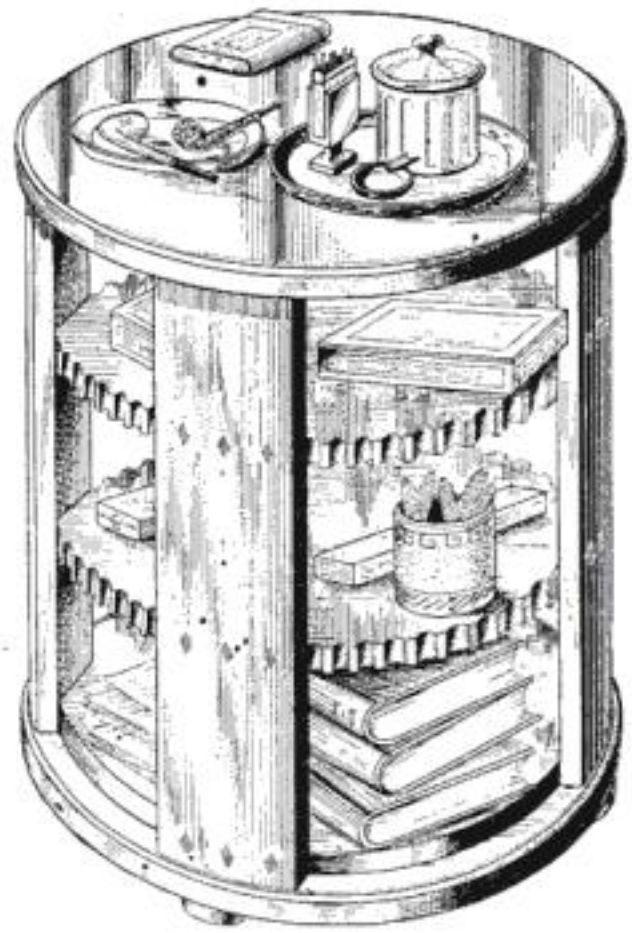
MODERNISTIC smoking stands have two advantages which should appeal to every man; they are substantial and convenient. The one illustrated, for example, is designed for hard service and, unlike the many ornate and fragile smokers which are manufactured for anything but utility, it is big enough to hold a large stock of smoking materials and accessories. Indeed, it can be used as an occasional table.

If the piece is to be given a stain and varnish finish, it should be of some good cabinet wood such as red gum; if it is to be painted with colored brushing lacquer or enamel, it can be of whitewood or some other close-grained, easily worked wood.

The tools needed are rip, cross-cut, back and turning saws, rule, try-square, marking gage, jack and block planes, ¼- and ¾-in. chisels, brace, auger and gimlet bits, countersink, screw driver, ½-in. gouge, half-round file, hammer, hand screws, clamps, and miter box.

First glue up the stock for the top, base, and shelves. It will also be necessary, if stock 1¼ in. thick is not available for the uprights, to glue together a ¾-in. and a ½-in. piece face to face to form each of them. By reducing the diameter of the top and bottom 1 in., the uprights could be made from ⅞-in. boards; while they would not look so substantial, they would be strong enough.

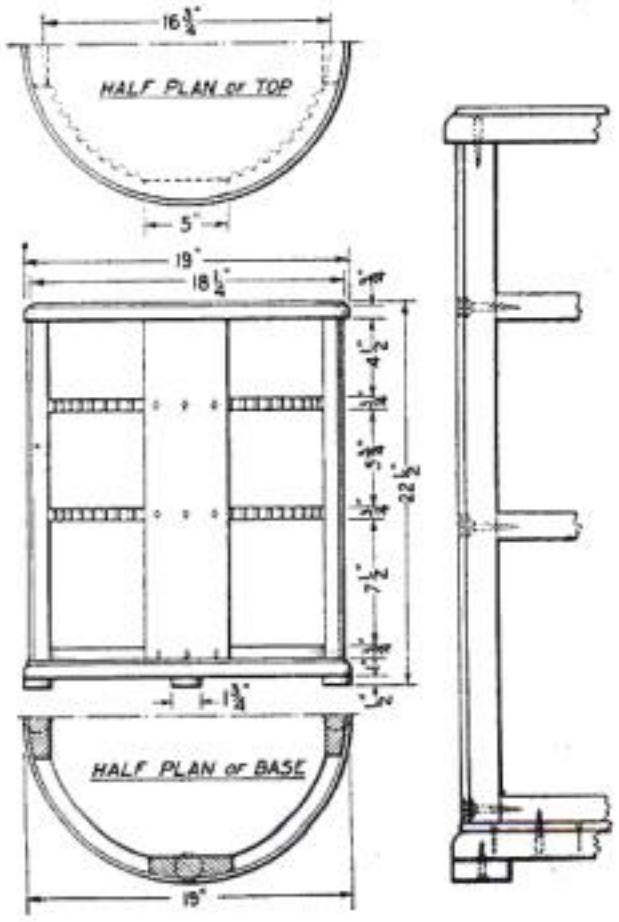
The central shelves are made 16¾ in. in diameter and are flattened at the proper points to allow the uprights to be attached. They are decorated by fluting the edges with a gouge and smoothing the wood with a rat-tail file and sandpaper. The uprights are planed to the proper curvature—that is, a radius of 9⅛ in. with the aid of a suitable template.



Sturdiness and simplicity are characteristics of this typically modern smoking stand.

The method of joining the parts is clearly shown in the drawings. The screws passing through the lower top are covered by the ¼ in. thick upper piece, which is cut to the proper diameter, smoothed, and glued in place. This piece, as well as the ¼-in. piece that is nailed to the bottom, should be cut from a sheet of plywood of the proper kind, if available. Obviously, the top and bottom also can be made of solid stock provided the top is fastened on in some way which does not allow any screws to show.

To hide the screws with which the shelves are fastened to the uprights, first bore a hole equal to the diameter of the head of the screw and ⅛ in. deep. In the center of this bore another hole for the screw itself with a gimlet bit or a twist drill. When the screws are in place and the heads sunk ⅛ in. deep, cut the diamonds from a thin piece of wood, place one of them over a screw hole, and mark its outline with a sharp knife point. Then remove the wood on the inside of the lines with a ¼-in. chisel and glue the diamond in place.



Construction of the stand. Note the position of screws and nails in the enlarged elevation.

Materials for the Stand

No. Pcs.	Parts	T.	W.	L.
4	Uprights.....	1¼	5	20
2	Top and base.	¾	19	19
2	Top and base.	¼	18¼	18¼
3	Shelves.....	¾	16¾	16¾
4	Feet.....	½	1¾	1¾

4 doz. flathead screws 1½ in.-No. 9

All dimensions are in inches

Home Workshop Chemistry

Simple Formulas that Will Save Time and Money

FEW tests the amateur can make on everyday household articles are as important or interesting as tests on butter. It so happens, too, that butter is more commonly adulterated than other foods.

Butter substitutes are occasionally found by chemists to be mislabeled with plain intent to defraud, especially in states which have poorly enforced pure food laws. The Federal Pure Food Law does not affect many locally distributed foods since it applies only to products shipped across the state line. If the amateur chemist wishes to check his work he can send part of the sample to his state food laboratory.

The following so-called "foam test," "curd test," and "melted fat test" have been used in food laboratories for years to aid in distinguishing between fresh butter, oleomargarine, and renovated butter. The latter is rancid stock that has been reprocessed by remelting the fat, deodorizing it, and then rechurning with fresh milk.

The only apparatus needed for the foam test is an old tablespoon and a small flame such as is given by a candle. Light the candle and gently heat about one quarter of a spoonful of the butter sample in the spoon. Under these conditions good butter will boil quietly and without sputtering, although much foam will form on the surface. Oleomargarine will sputter like a boiling mixture of fat and water, but will give little foam. Renovated butter acts like oleomargarine.

TO PERFORM the curd test, pour about a cup of sweet milk into the inner part of a double boiler, fill the outer part about a quarter full of water, and heat until the milk has reached nearly the boiling point. Add about two teaspoons of the butter sample to the hot milk and stir with a spoon until the butter is melted. Then remove the boiler from the stove and substitute ice and ice water for the hot water in the bottom part. Continue the stirring until the butter has again solidified. Under these conditions good butter will form granules which mix with the milk. Oleomargarine will collect in a single mass, which can be easily removed from the cold milk with the spoon.

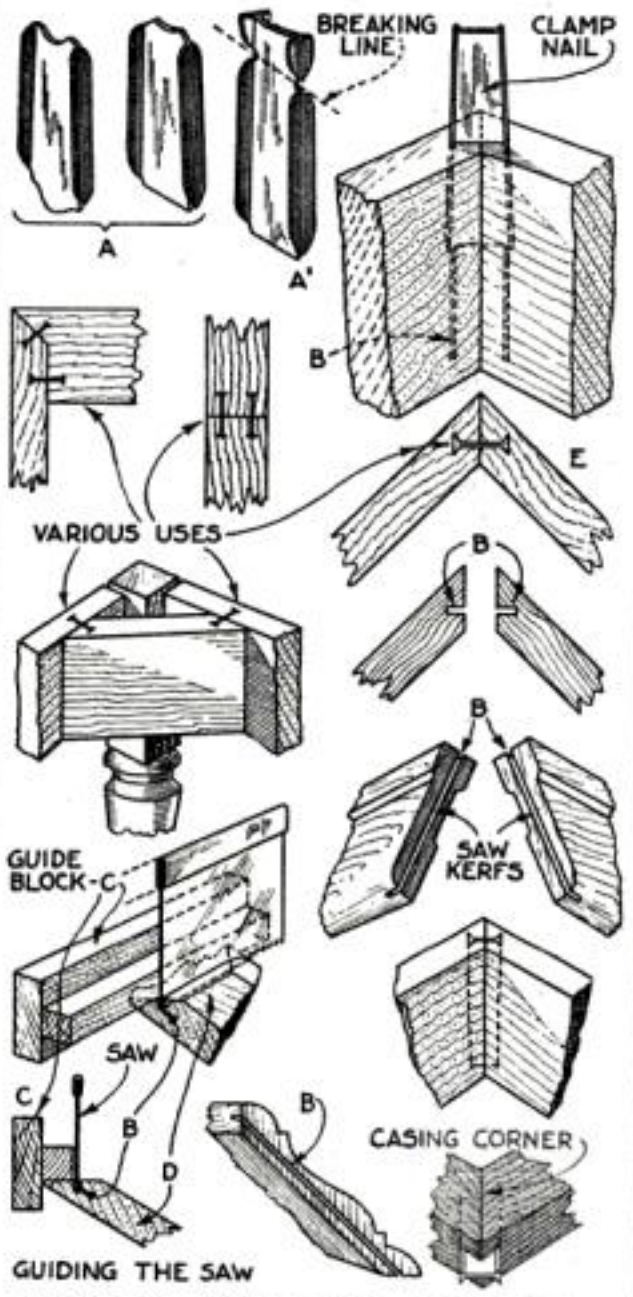
For the melted fat test, place about one half cup of the butter sample in a jelly glass and melt by holding the glass in water that has been heated to about 120 degrees Fahrenheit. This temperature will melt the butter but is not high enough to spoil the test. After a few minutes hold the tumbler against the light. The curd from fresh butter will have settled, leaving the melted fat above it clear and transparent. In the case of renovated butter, the fat will be turbid from feathery particles of curd.—W. H. HAMMOND.

Strong Joints Made with Clamp Nails

By DAVID WEBSTER

CLAMP nails may be used as substitutes for nails, screws, dowels, and glue upon work which involves joints like those illustrated. If your local hardware stores do not carry them, you can order them by mail from large hardware supply houses.

The ordinary clamp nail, which is shown at *A*, can be obtained in sizes ranging from 3/8 to 11/16 in. in width and from 1/2 to 3 in. in length. A continuous



How clamp nails are used, particularly in mitered joints; method of cutting slots for them.

form of clamp nail also can be obtained as shown at A^1.

Grooves or saw kerfs must be cut to receive the clamp nails as at *B;* these may be made on a well-conditioned circular saw or by hand.

To cut grooves by hand, prepare a guide block *C* and place it on the work *D*, as shown. The depth of the cut should be a little more than half the width of the clamp nail to be used.

The members of the joint should be held firmly in correct relation to each other while the nails are being driven. Insert the wider end of the clamp nail so that the flange will cut its own path as it is driven and at the same time draw the joint into as nearly perfect contact as possible. One nail, as at *E*, will be ample for most joints, even without glue.

Old Gun Converted into Floor Lamp

AN OBSOLETE shotgun or hunting rifle or a discarded modern Army rifle can be made into a useful and ornamental floor lamp as shown in the accompanying illustrations.

Make the base 2 in. thick and at least 12 in. in diameter by turning it from wood on a lathe faceplate. Remove the butt plate of the gun and fasten the stock to the base with two large wood screws or lag screws 5/16 in. in diameter and 4 in. long.

In case the base is not heavy enough for the gun, a recess with dovetail edges can be turned in the underside and

Sportsman's lamp made by adding a base, electric fixtures and shade to an old shotgun.

then afterwards filled with melted lead.

An electrician can supply the fixture and attach it by threading the muzzle. In the case of a muzzle loader, it will also be necessary to drill a hole through the breech or side of the barrel large enough to allow the fixture wires to be drawn through.—E. A. CLEVELAND.

Table Extension Aids in Perspective Drafting

MECHANICAL draftsmen are occasionally called upon to make perspective drawings, and architectural draftsmen, of course, frequently have to prepare them. Unless the work is done on a table of unusual length, it is impossible

A framework is laid on the drafting table to carry the pins for the vanishing points.

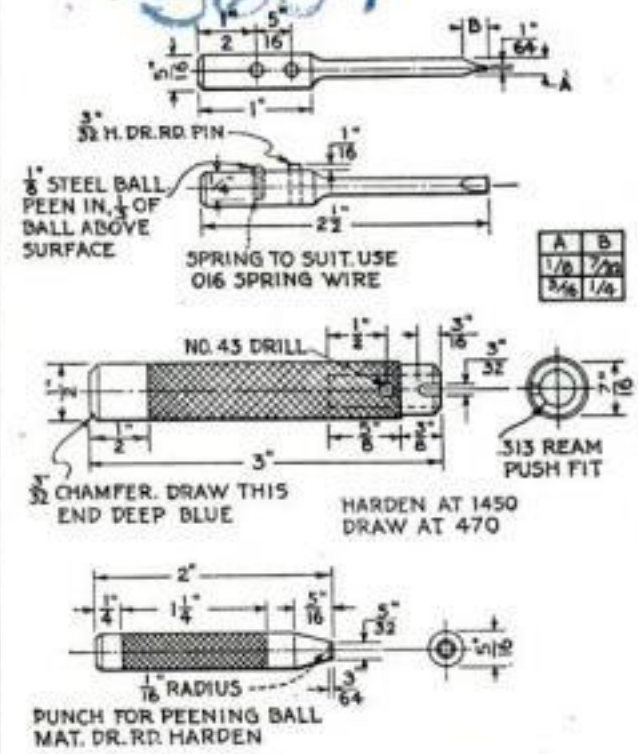
to drive pins at the vanishing points and carry a long, straight edge out to them.

Various expedients are used to overcome this difficulty. One of the simplest is illustrated. A light extension frame is made to rest upon the drafting table or desk. Pins to represent the vanishing points can be driven into the frame wherever necessary.—J. D. G.

Making an Interchangeable Screw Driver Set

BOYS who are studying machine shop practice in high schools, vocational schools, and in shops can gain practical experience in turning, drilling, reaming, centering, knurling, milling, filing, hardening and tempering by making the screw driver set illustrated.

Only one handle need be made, but blades of various sizes, as well as drift pins, punches, awls, scribers, nail sets, and center punches can be



Interchangeable screw driver blades with a handle, which may be used for other tools.

made up and inserted into the handle.

The equipment required is as follows: Bench lathe, drills, reamers, knurling tool, file or mill, and hardening furnace.

The operations for the handle are: Cut 3 in. off a piece of ½-in. drill rod. Face and center one end. Drill and ream .313-in. diameter. Drill hole with No. 43 drill. Drill and file elongated slot. Turn 7/16-in. diameter and chamfer. Knurl. Harden and draw head to a deep blue.

For the screw driver blade shown the operations are: Cut 2½ in. off a piece of 5/16-in. drill rod. Face and chamfer end. Turn down blade. Drill holes. Mill or file the blade. Insert pin, spring, and ball. Harden blade and draw. For peening ball, a small peening punch can be made like the one shown.—ALBERT NELSON.

Cleaning Oily Shop Floors

TO KEEP the floor of a shop in good condition, lime is sometimes used instead of a sweeping compound. It is swept over the floor every day in such a way that very little remains on the wood, but that little counteracts the effect of oil and grease and makes it easy to clean up whatever has fallen on the floor. The treatment, if persisted in, improves roughly used floors.—EDWARD PIRANIAN.

New Floors Overnight

(Continued from page 104)

in using materials that dry before your eyes. Besides, the semidull sheen of lacquer finishes is pleasing to the majority of people and corresponds with the sprayed lacquer finishes of the highest-class furniture. With the improvements that have been effected in brushing lacquer during the past year, the home worker as a rule has no difficulty in using them for the finishing of small pieces.

When it comes to comparing the four-hour varnishes and enamels with lacquer for such requirements as the finishing of floors and interior woodwork, the advantages are in favor of the newer materials. The varnishing of a floor, for instance, is a different matter from doing a small end table or a sewing cabinet. It is not so easy to apply the cellulose-type lacquers on a large surface of this kind and handle the brush so deftly that laps will not show. This also is true of interior woodwork. Very little brushing lacquer has been used for this purpose by home decorators, although professional painters have made effective use of lacquer finishes in some public building work of the better class.

The durable new four-hour varnishes and enamels, on the other hand, are just the thing for floors and woodwork. They can be used as easily on large surfaces by the amateur painter as the ordinary varnishes and enamels which he has been accustomed to use.

IN SUMMARIZING, the best current practice for amateurs seems to be as follows:

Brushing Lacquers. Use for unpainted furniture and woodenware novelties, for refinishing furniture, and for all similar decorative requirements.

Four-Hour Varnishes and Enamels. Use for floors, interior woodwork, and other architectural requirements.

Standard Varnishes and Enamels. Use for all purposes where a varnish or an enamel finish is desired and there is ample time for the surfaces to dry before use.

It should be remembered, of course, that there will always be those who have a decided preference for either an enameled or a lacquered finish, as well as certain individual requirements which may make one or the other way more suitable. The preceding classification is purely for the convenience of those who have had little or no experience with the various finishes; those who have used them to a reasonable extent will understand the differences from actual experience and can use their own judgment.

Four-hour varnishes and enamels may be applied over either new wood or previously painted, varnished, enameled, or lacquered surfaces. Prepare the work in the usual way in respect to cleaning, sandpapering, and dusting.

Generally speaking, the handling of the new materials is the same as the old-line varnishes and enamels; however, a few precautions should be taken. Being generally of a heavier nature than the ordinary varnishes and enamels, they should be flowed out in a thinner coat than has been the usual practice. The surface cannot be brushed for as long a time and a closer watch must be kept for sags, runs, and other defects. Formerly some painters made it a practice to coat a considerable amount of surface before going back and "picking up" runs with a corner of the brush, but it will be found that this cannot be satisfactorily done with the four-hour drying materials.

While durability was sacrificed to some extent in the first finishes of this type placed on the market, improvements have been discovered, until now many of the high-grade makes of four-hour drying floor varnishes have practically the same durability under hard wear on floors as long-oil and spar varnishes of well-proved quality.

Drilling Holes in Glass

(Continued from page 98)

four through which has been bored a hole just large enough to allow the tube to rotate freely.

In the process of boring with a tube, which should be cut square on the end, carborundum or other abrasive powder is used as the grinding agent. In order to allow this powder to enter under the edge of the tube, eight or more shallow notches are made as shown in Fig. 4.

The jig is then fastened on the worktable as shown in Fig. 5, and the plate placed in correct position under the tube. Carborundum powder may be poured into the tube or applied outside

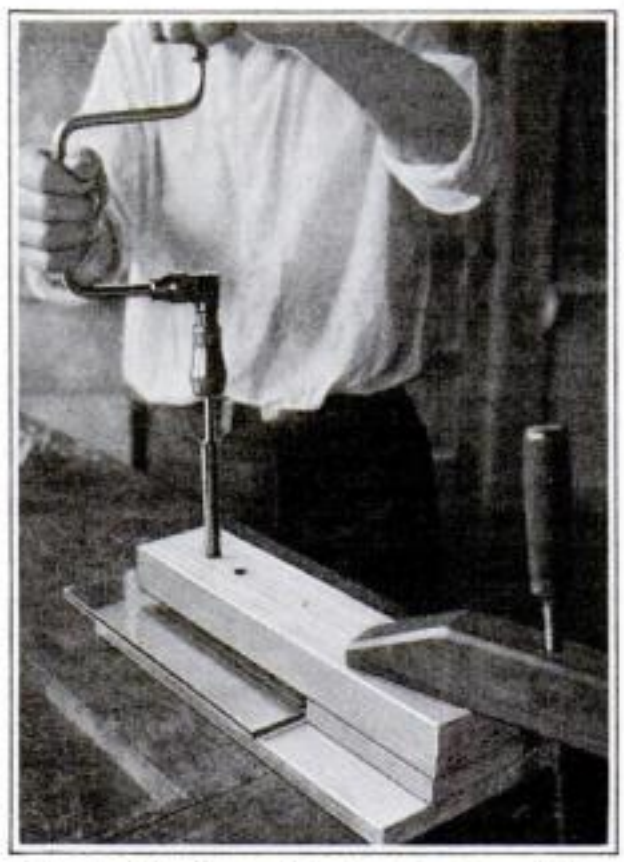


Fig. 5. Grinding a hole in plate glass with a brass tube charged with fine abrasive powder.

of it, together with a small amount of water. The glass is clamped down or wedged in to prevent its moving when the boring begins.

A rose countersink or a reamer set in the brace or drill stock will serve to rotate the tube, for no great power is necessary. The use of a drill press or lathe or any other application of motor power reduces the time necessary for the job.

If care is taken, the tube can be allowed to cut through the glass, but a safer way is to reverse it, provided the jig can be fixed in exactly the right position on the opposite side.

A little practice will teach just how much pressure can be applied for best results in cutting. After the groove has been made, it should be kept filled with water; and additional abrasive should be applied when necessary. If the edge around the hole is somewhat sharp or rough, polish it with carborundum powder held on a piece of wet cloth or rubbing felt.

Striping with Lacquer

AFTER painting a cabinet with a small air brush, I wanted to draw some very thin, fancy lines on the corners with dark lacquer. Knowing the difficulty of doing fine striping with a brush, I removed the lead from a discarded mechanical pencil and turned the mechanism until the hole at the point of the pencil was plugged with the wire that pushes out the lead. Removing the cap and eraser from the other end, I filled the barrel with thin lacquer. Then I released the wire at the writing end a trifle and did the striping as if I were drawing with a pencil.—SAMUEL TRONCOSO.

BEFORE painting exterior concrete or stucco, scrape off any efflorescence or white spots and apply a wash of 3 lbs. sulphate of zinc to 1 gal. of water.

"Ten Thousandth" Touch

(Continued from page 94)

Wear may have affected the flatness of the anvil face and perhaps the spindle face, as is shown at *E*, which will produce the same kind of error. When this is discovered, the anvil and the spindle must be lapped to flatness, or else the tool returned to the maker for the repair.

Figure 7 shows a test that will reveal an inaccuracy of this type. The anvil is slightly blackened with a delicate coating of soot from a candle. When the face of the spindle is brought into contact with the anvil, the points that meet, or where "the shoe pinches," are instantly shown. Another way to test the spindle and anvil for parallelism is to use a narrow strip of shim metal as a feeler as in Fig. 8. The feeler should be equally tight at all points. The simplest test for the truth of the spindle is by revolving the spindle against an indicator as in Fig. 9, while the micrometer is clamped to the bench.

WITH these various tests made and repeated from time to time, we can know that our micrometer will measure "right to the scratch," always provided that we supply the one indispensable and important factor—a proper measuring pressure.

For those who have small experience or whose fingers lack sensitiveness, the use of the ratchet is best. The ratchet, however, has the disadvantage of lessening the control of the fingers on the barrel. On very exact measurements it may even defeat the purpose for which it was designed; indeed, it is rarely used by toolmakers who habitually have much highly accurate work to do. In any case, however, there is but one way to acquire the "ten thousandth" touch, and that is by persistent practice.

What has been said about the micrometer applies in large part also to the vernier caliper. Objects of the same length or diameter may give different readings, as shown at *a* and *b* in Fig. 10, because the jaw surfaces are worn at the outer ends, as at *B*, because the jaws are disaligned as at *C*, or because the bar has become worn or sprung, as at *D* and *E*. The effects in each case will be different, but a study of the diagrams from *A* to *F* will suggest the best ways of testing. A caliper cannot be expected to be as accurate as a micrometer, but if a correction seems necessary, the best plan will be to send the tool to the maker.

While many of the tests and checks that have been outlined may appear to be carrying a good thought too far, it must be pointed out that if we want to work "right to the scratch," none of them is superfluous. All of our tools must be checked and rechecked to an accuracy more precise than we ourselves expect to obtain in our work.

In almost every case the remedy for error is to return the tool to its maker for correction, for he has the facilities and the skill required to do a first-class job in reconditioning it. But before he can do that, it is up to you to find out when your tools are "out."

Experienced mechanics will recognize in this series of articles by Henry Simon—the present article being the sixth—a contribution of outstanding originality and practical value to the literature of the machine shop. As a mechanic, engineer, designer of tools and fixtures, manufacturer of precision tools, and now a writer of international reputation on mechanical topics, Mr. Simon is placing at the disposal of the readers of this department the knowledge acquired in studying shop methods for many years. The next article, which he wrote as a sequel to this, is scheduled for early publication; it will discuss the use of squares.

Hints for the Shopman

(Continued from page 96)

which will be described, use is made of this property of lapped surfaces to stick together. Only elementary tools are needed, yet the test, while comparative only, will reveal the presence of an error of about 1/40,000 in. and will prove the truth of parts within this limit.

At *A* and *B* in Fig. 4 is shown the usual toolmaker's angle iron and beam square. It is assumed that each is lapped so that they are practically perfect and that the beam of the square will stick to the angle iron.

If the beam of the square is wrung to one face of the angle iron and the blade moved down to the other face, the blade should make contact with the second face so perfectly that no light will be visible. If light is visible, the error is at least 1/40,000 in., since this is the

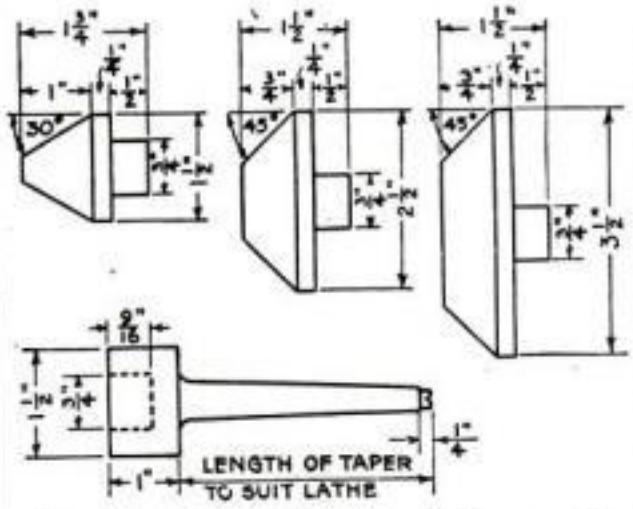


Fig. 6. Set of live tail centers which are useful for turning pipe or tubing in a small lathe.

smallest opening through which light can be seen by the naked eye. If the blade is raised from the contact, there should be present the so-called "sweat mark," which will also indicate that the blade was in uniform contact with the angle iron.

Now, if a gage block or jig part such as *C* is placed between the angle iron and the square blade, its parallelism will be indicated in the same manner. If two gage blocks are to be compared, as *D* and *E*, their equality will be shown if light cannot be seen above either one.

While the inaccuracy of any given piece of work cannot be measured definitely by this method, it should be useful in bringing parts to exact parallelism, and in checking one part against another.—DANIEL F. MORIARTY.

FIGURE 5 shows the use of a tool that produces an excellent finish on steel, wrought iron, or bronze in the planer, shaper, or slotter.

Its principle is that of shearing off a thin, curled shaving with the side of the tool. As will be seen from the sketch, the cutting edge is at an angle of 30 degrees from the center line and is formed to a 4-in. radius, so that the cutting is done at a point near the center of the tool. The point should be about 1/8 in. thick. The clearance should be 2 degrees.

The tool should be used with a fine feed; and when steel or iron is being cut, oil should be used as a lubricant. In machining most bronzes, no lubricant is required. The depth of cut should be about .020 in. The tool should be stoned to a keen cutting edge. Often when using this tool it is hard to see the tool marks at all.—ALBERT M. THOMAS.

WHEN pipe or tubing is turned in a small lathe, large centers of some type are necessary for the tailstock. More satisfactory results will be obtained if these centers are made to revolve. In Fig. 6 is shown a set of live tail centers that the writer made for a 9-in. lathe. For larger lathes, the proportions can be increased. The revolving parts are machine steel, casehardened, while the shank is of tool steel, left soft.—FRANK N. COAKLEY.

Varnishing a Front Door

(Continued from page 90)

best results can be obtained when you can replace the front door with a temporary shed door and remove it for refinishing to a room that can be kept free from dust. It goes without saying that the edges should be finished with the same care as the exposed surfaces; otherwise moisture will get into the wood and cause serious damage.

Doors of oak are finished in the same way except that if a smooth, glossy, and well-filled surface is desired, paste wood filler must be applied after the stain. For a door that is to be a natural or light oak color, use natural paste filler; for brown oak, use a dark oak or walnut filler. The filler comes in one-pound and larger cans; it is a heavy paste, which must be thinned to a thick, creamy consistency with turpentine.

The Materials Needed

- ½ pt. ready-mixed oil or spirit stain or wood dye (oil for new work and spirit stain for old).
- 1 lb. paste wood filler, either natural color or the shade desired.
- 1 pt. spar varnish for exterior use.
- ½ pt. bleached or white shellac and ½ pt. alcohol to thin it (used only for a two-tone gray stained finish with white filler).

Apply the filler with an old, short-bristled paint brush. Rub it well into the wood, allow it to stand for from five to fifteen minutes until the surface becomes flat, and wipe it off with a wad of excelsior, waste, or rags. Wipe only across the grain, but clean the surface well to avoid a clouded, dirty finish. If you wipe with the grain, you will drag the filler out of the wood cells and defeat the object of filling. The same is true if you start wiping before the filler is flat; yet if you allow the filler to set too long, it will be tough and hard to wipe. At the right moment it will roll up and off the surface easily, leaving the cells well filled. A second time over with clean excelsior or rags may be necessary to get it all off.

Allow the filler to dry hard overnight and then sand the surface with No. 0 or ½ paper. Clean the door with a cloth damp with turpentine or benzine, and you are ready to varnish.

Some oak finishes, such as weathered and Jacobean brown, are not filled; the open wood cells remain visible as part of the finish.

THE two-tone gray finishes on oak are obtained by using a ready-mixed gray stain, followed by a thin coat of white or bleached shellac. For this purpose thin the liquid shellac you buy with an equal amount of alcohol. Spread it on thin and when dry (in about an hour) sandpaper it lightly with No. 0 paper. After that apply a white paste filler and wipe as described above. You can buy white paste filler in some large paint stores, but if you cannot get it, use natural paste filler to which a very little white lead (not more than one fifth of the bulk of the filler) may be added to make it whiter. Take out of the pail or keg the lead that is thick and has little oil; then thin it with a little turpentine before adding it to the filler. For finishing, use the lightest colored spar or outside finishing varnish you can get; very dark varnishes spoil the effect of a gray finish.

The gray finish, as well as the weathered oak and Jacobean finishes, are best rubbed dull. A high gloss is not appropriate.

Birch, gum, redwood, and cypress require no paste filler, and the finishing is as described for pine doors. Birch usually is stained but the other three are often finished in their natural color, without stain.

A novelty finish sometimes used on cypress is called Japanese sugi. (Continued on page 118)

Varnishing a Front Door

(Continued from page 117)

The surface of the wood is burned with a gasoline blowtorch until uniformly charred; it is then scrubbed with a steel wire brush to remove the black char and yet not cut through the beautiful brown color of the wood underneath. This removes the soft pulp wood and leaves the sap veins standing in high relief.

After wire-brushing the surface, brush it off and fill it with a white paste filler as described for the gray oak finish. Wipe the filler and let it dry. Finish with a thin coat of the lightest colored spar varnish or exterior varnish you can get, thinned about twenty-five percent with turpentine. When dry, apply a coat or two of the same varnish as it comes from the can. The last coat should be rubbed dull for the best effect. Wax is the usual finish on sugi interior doors but will not last outside.

Another article by Mr. Vanderwalker on refinishing outside doors with paint is scheduled for early publication. Both among professional painters and amateurs, Mr. Vanderwalker is recognized as one of the most thorough and practical writers on painting and decorating.

Casting Concrete Seats

(Continued from page 86)

For one seat, 1 bag cement, 1½ cu. ft. sand, and 2 cu. ft. gravel will be ample.

In placing the seat in its desired location, dig holes about 8 by 16 in. in area and about 10 in. deep for the ends to rest on. These holes are filled with a mixture of one part cement to three parts sand and gravel. Let this dry overnight and then lay a mortar of one part cement and one part sand about 1 in. thick for the ends to rest upon. Use loam to fill in level with the grade so grass will grow.

Portable Workbench

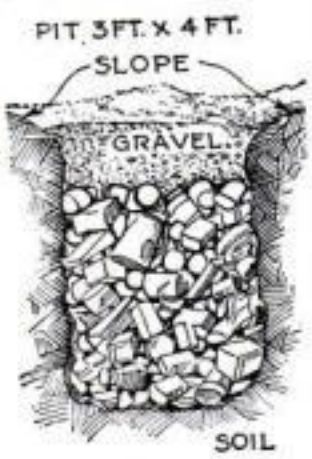
(Continued from page 100)

and 1½ in. from the end of the hinged pieces to which they are attached.

This simple device works perfectly. When filled with tools, including the heavy vise, it takes all the strength of two men to lift the cabinet, yet when the casters are set in place under it, I have moved it wherever I desired with one finger. In the two years I have been using it, the bench has never failed me. I have made many things upon it—bookshelves and plant stands, several hanging bookshelves, a linen closet, a pier cabinet, and a cupboard (illustrated) for groceries and supplies with shelves above like a Welsh dresser.

Drain for Back Yard

MANY back yards or gardens have low spots where water accumulates in rainy weather. In the writer's case it was the poultry run which became flooded. To overcome this a pit 3 ft. in diameter and 4 ft. deep was dug, and into this were dumped tin cans, bottles, broken crockery, and the like. On top of this gravel was piled to a depth of about a foot. The dirt removed from the hole was spread around to raise the level of the chicken yard at a very gentle slope. When the filling settled after several heavy rains, more gravel was added. —HI SIBLEY.



Loosely filled pit in center of low area.

Repairing Shingled Roofs That Leak

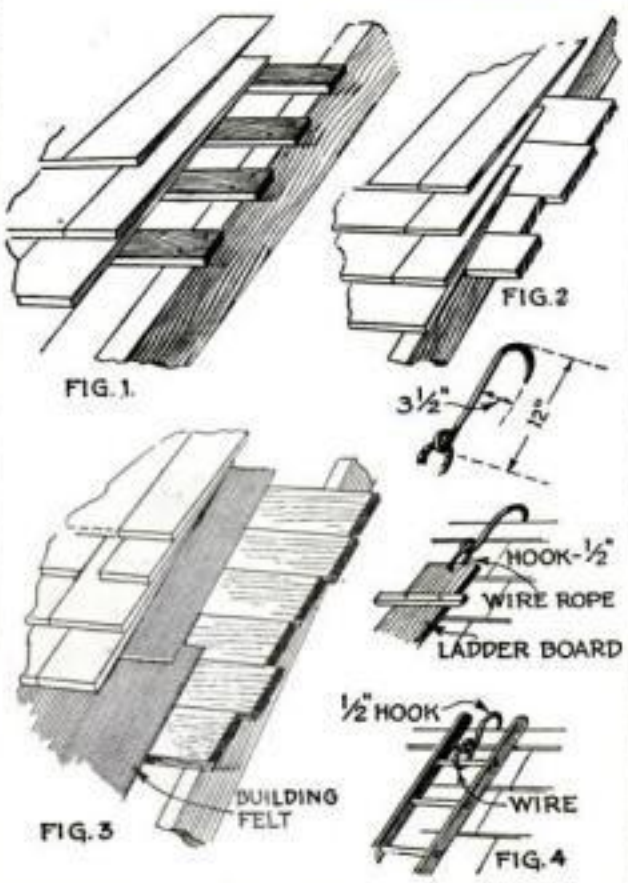
Paste this Home Workshop Reference Sheet, including the head above, in your scrapbook in the section marked *roofs*. (May, 1929, POPULAR SCIENCE MONTHLY.)

What shall we do with a leaky shingled roof?

USUALLY the repairing of a leak when found and reached is a comparatively simple matter, but when shingles are blown off from different parts of the roof, it is good evidence that all the nails are rusted so badly that repairs will be like putting a new patch on rotten cloth. The only logical and economical thing to do is to cover the entire roof, for the cost of repairs will largely be wasted.

To locate the leak we must consider the method by which the roof was boarded in. If the roofing boards are strips 2½ in. wide as shown in Fig. 1—the method used in many western and southern states—the locating of a leak is not difficult. Go into the attic on a sunny day and push a finishing nail or a sliver of wood through every place where light can be seen or where discoloration indicates that water has come through. This will locate most of the leaks so that they may be repaired from the outside, as indicated in the photograph on page 120. Probably other leaks will be missed, for a split shingle may come over a rafter, or be several shingles above the place where the water stains show on the inside. Even where no light comes through the overlapping shingles, a high wind may sometimes drive the rain through.

One person inside to push the splinters through and another outside to do the repairing make an excellent (Continued on page 120)



Three types of shingled roofs, and how a ladder or a ladder board is used for working on them.

Repairing Shingled Roofs

(Continued from page 119)

Tin or asphalt patches are slipped under the shingles wherever the leaks have been marked.

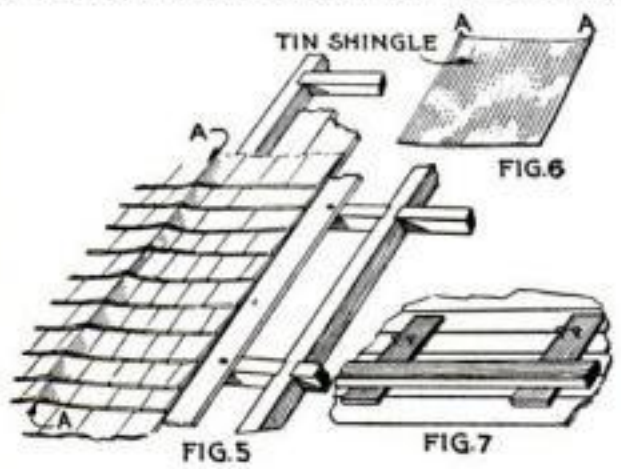
team for fast work in patching a bad roof.

When a roof is boarded with square-edged boards as in Fig. 2, or with matched boards, as in Fig. 3, perhaps covered with waterproof building paper or felt for heat insulation—methods used in the northern belt of states—the locating of leaks is not so simple a proposition. It is not unusual to find, after futile attempts at repairing such a roof, that the leak is several feet above the point where the water comes through inside.

Often in locating a leak in the roof of an old house we find the roofing boards were laid from the eaves to the ridge with bearings from three to four feet apart as in Fig. 5. This, of course, gave few nailings, and allowed the boards to spring and vibrate so the nailing was difficult and uncertain. There may be a continuous line of split shingles as at *A*. The only way to locate leaks in roofs like those shown in Figs. 2, 3, and 5 is by working from the outside of the roof.

What is the best and safest way to work on a roof?

THE ladder and ladder boards shown in Fig. 8 have stood safety and efficiency tests for many years. They are held in place by a stout hook over the ridge or saddle boards, as indicated in Fig. 4. The shingles are usually so dry and brittle that climbing about the roof is almost certain to split some; hence the ladder and ladder board are not simply aids to climbing, but they reduce the danger of splitting more shingles.



A type of construction sometimes encountered; a painted tin shingle, and a shingling bracket.

Start at the ridge of the roof and work down as far from the ladder as may be reached conveniently; then climb back to the ridge, move the ladder over, and repeat the process. The roof may be reached by a ladder from the ground or from an attic window.

Unless one feels perfectly safe, a light scaffolding may be built, as suggested at *A*, Fig. 8. The inner end of the ledger *B* may be fastened with eightpenny common nails driven carefully into the (Continued on page 121)

Repairing Shingled Roofs

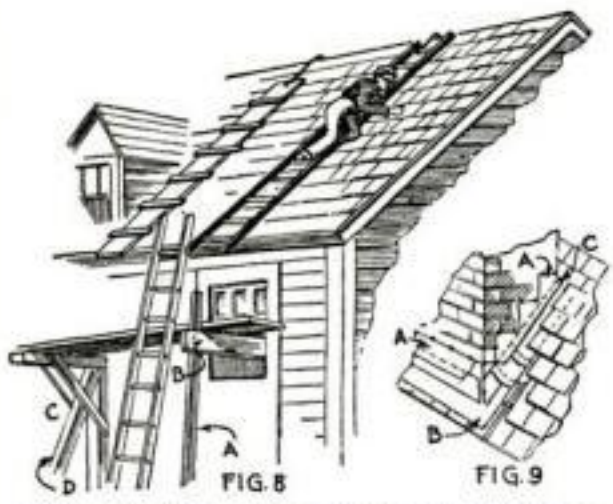
(Continued from page 120)

edge of the casing. Let the heads project so the nails may be drawn easily. Perhaps a neighboring carpenter may be willing to lend his scaffold brackets. One type of bracket may be supported from the ground by a piece *D*, Fig. 8, thus eliminating the building of scaffold *A*, but always guard against side swaying.

A simple but common type of shingling bracket is suggested in Fig. 7, which is often used on new work. It consists of a piece of "two by four" with shingles nailed to it and held in place on the roof by nails through the shingles into the roof. In a new roof these nail holes will disappear with the first rain, but on a very old roof the nails may split more shingles.

What equipment is necessary for repairing a shingle roof?

THE most important equipment is mental and consists of one's confidence in his ability to do the work and the gumption to make the attempt. The expression of these qualities will require but few tools beside the ladders and scaffolds. (1) A hatchet for trimming shingles and nailing, though a hammer and a stout knife will answer the purpose. (2) A shingle nail cutter or ripper *A*, Fig. 10, used as in the photograph on page 122, or a notch filed in the back edge of a narrow pointed cutting off saw as at *B*, Fig. 10, to slip under shingles and cut off nails in the same way. The saw itself will be used in fitting hip and valley shingles. (3) Tin shears to cut sheet metal for flashing and for making tin shingles. (4) A putty knife or an old case knife for applying cement around the flashing. (5) A soldering iron and blowtorch, or an electric soldering iron, if current is available, may be necessary. (6) A pair of ordinary lightweight rubbers or "sneakers" should always be worn while working on a roof, for they greatly decrease the danger of slipping, shingles will not be so badly broken, and it is possible to walk over roofs not steeper than one third pitch.



Methods of erecting scaffolds and using roof ladders; the application of chimney flashings.

What materials are required for repairing a shingle roof?

THIS depends largely upon the condition of the roof. We shall assume that the roof is in such bad shape in both shingles and flashings that we question whether it will not be better to re-lay the entire roof. For such a roof we shall need: (1) New shingles for replacing those either blown away or beyond repair. (2) Painted roofing tin, zinc, or galvanized iron, or tin cut from tin containers. The last should be painted on both sides and allowed to dry. These sheet metals are to be cut into tin shingles ranging from 3 or 4 in. by 5 or 6 in. and are for slipping under split shingles. Pieces of one- or two-ply asphalt roofing of the same size are also used for the same purpose. Provide plenty of these. Such a roof as we have in mind cannot be made to last more than a (Continued on page 122)

Repairing Shingled Roofs

(*Continued from page 121*)

few years longer, hence these will last until the entire roof must be relaid. Also necessary are copper or tin for repairing flashing, fourpenny shingle nails, and a few eightpenny and tenpenny common nails for nailing flashing into the chimney. (3) Often upon a repair job the liberal use of asbestos or elastic roofing cements will do well enough as a makeshift for repairing flashing instead of using solder. (4) Solder and fluxes—muriatic acid cut by dissolving in it as much zinc as it will take up, for use upon galvanized iron or zinc, and rosin for use on tin.

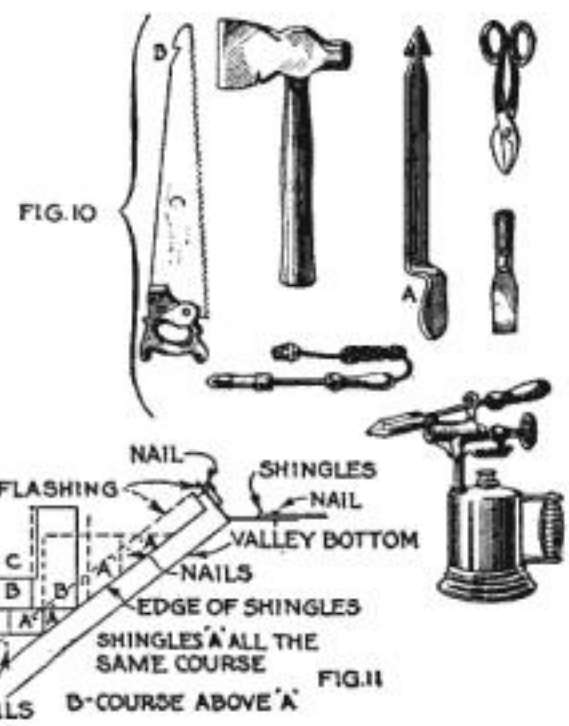
How are leaks in a shingle roof repaired?

1. A SPLINTER of wood pushed through the roof from the attic and showing as at *A* in the photograph on page 120 requires that a tin shingle or a piece of asphalt roofing should be pushed under the split shingle until it is out of sight. The upper corners of a tin shingle should be turned up a little as at *A*, Fig. 6, which will hold them in place. Asphalt shingles will melt enough the first hot day to stick to the wood shingles and stay in place.

Drawing nails with a shingle "ripper."

2. Other shingles may be split as at *B* in the photograph last mentioned. Even if they do not leak at present, prevention is the policy, so we will slip a tin or an asphalt shingle carefully under the split.

3. Some shingles may have been blown off or badly split. These may be replaced with new shingles. First cut off the nails of the shingles just above the splits by using the ripper. This will allow the split shingles and those around them to be removed easily. Usually a quick pull with the hand will cut a nail, but if not, a hammer or hatchet may be used to strike the ripper. Lay the new shingles to conform to the courses, nailing them not less than 5 in. from the butt, and break joints at least ¾ in. with the joints in the course immediately below. One objection to the use of new shingles is the color contrast between them and the old roof, which gives the roof a freckled appearance. This may be helped by bringing the new (*Continued on page 123*)



Some of the tools used in making roof repairs, and a diagram of a typical shingled roof valley.

Repairing Shingled Roofs

(Continued from page 122)

shingles to about the same color as the old with a thin stain of linseed oil and turpentine, half and half, with a little japan and dry color—lampblack or burnt umber. Asphaltum thinned with turpentine will serve the same purpose. By the time the stain has disappeared, the weather will have so equalized the colors that the repairs will be noticed by few.

4. Do not drive shingle nails so hard that the heads of the nails sink deeply into the wood, for this will break the wood fibers and may later split the shingle. Drive them until the head rests lightly but firmly on the shingle.

5. Often in repairing hip or valley shingles, tin or asphalt shingles will be all that is necessary, but if new shingles are required, use care in removing the old ones in order to see how they were fitted and laid. Valley shingles should be cut from the part of the shingle where the thickness is the same as the rest of the course, that is, the thin or top end of each valley shingle should rest on the same horizontal line as the rest of the course to keep the thickness of each course the same until it is finished at the valley, as at *A*, Fig. 11. Be very careful that no nails are driven into the flashing lower than necessary, say one inch from the top edge of the flashing, or a bad and invisible leak may result. Hip shingles rarely give trouble, as the water runs away from them, but if any have been blown off or been badly split, the method of re-laying them must be governed by the way they were laid originally.

How may leaky flashings be repaired?

SHINGLES and their metal flashings are so closely related that they cannot well be considered separately. Often a surprising amount of rain water will find its way through a rust hole no larger than a pinhead. Though a few such holes may be mended with solder or roofing cement, if the flashing appears to be rusted through, it may be economy to tear it all off and reflash.

1. Usually if leaks appear within 4 in. of a chimney, it is safe to assume that the flashing is not doing its duty. Unless the leak can be reached and repaired without removing the shingles, they will have to be taken off and perhaps the entire flashing relaid. Begin at the top and notice how the work was done in the first place. Duplicate it with care, especially the method of joining the shingles and the flashing. While this work may be worth while upon a slate or asphalt roof, it should be avoided upon a shingle roof if possible.

2. Usually a careful and liberal puttying or doping with asbestos or elastic roofing cement, or a little judicious soldering and the use of tin or asphalt shingles, will cure any leak in flashing not more than twenty years old, if it was well laid in the first place.

3. A leak or a prospective leak may be located by pressing against the suspected point with the finger or the point of a nail or jackknife. If a firm pressure breaks through, the metal should be repaired. In any case the counter flashing *A*, Fig. 9, should be plentifully recemented and nailed with flashing nails or eight- or tenpenny common nails, for their heads will hold flashing to the brickwork very well. Drive them slantingly and they will hold better.

4. Owing to the difference in the expansion and contraction of the roof and of the chimney corners, the flashing at *B* and *C* of Fig. 9 may require resoldering. If flashing leaks are not too bad, a coat of heavy roofing paint or canvas bedded in roofing paint may be sufficient to keep the water out until a new roof becomes imperative. After the flashing of an old shingle roof has come to need repairing, it is seldom good economy to spend much money in repairing it; usually the simplest repairs will extend its life until a new roof must be laid.—C. A. K.

A Model for Long Flights

(Continued from page 81)

lower sidepiece. Paper the fin and treat it with light dope. It should weigh between .05 and .06 oz.

The propeller (Fig. 5) as made by Shifler-Smith was in two pieces. You can, however, use a standard type blank such as that described in connection with the Morris model in the March issue of POPULAR SCIENCE MONTHLY, the blank being ¾ by 1⅜ by 16 in.

By using two pieces, however, you save considerable balsa and also are assured that the shaft will be properly located. In this case, use a blank ¾ by 1⅜ in. (plus the width of the saw which you expect to use in sawing the blank apart) by 8½ in. Cut the block diagonally in two as shown, and with ruler and pencil scratch a small groove for the propeller shaft ½ in. from the narrow end. Do this in each piece.

Make the shaft of No. 13 music wire, 1⅜ in. long, as shown in Fig. 6, and lay it in the groove. Anchor the U-bend in the balsa wood. Cement the two halves of the blank together and allow them to dry for several hours in a warm place.

Next carve the propeller, which should have a 32-in. pitch. At the hub it should be 3/16 in. thick; at the tip 1/16 in. The hub should be 7/16 in. from front to back when completed. Round the tips as shown.

Give the propeller four or five coats of banana oil and an extra coat or two on the entering edges and tips. Sandpaper the blades very lightly and check the balance after each coat is dry. Even a slight error in balancing will cause the model to vibrate and fly inefficiently, if at all. If your propeller weighs about .12 oz., you may consider that you have done a good job.

The motor consists of ten strands of fresh 1/32 by ⅛ in. flat rubber, which is what Shifler-Smith used on his record flight. It should weight about .75 oz. Make the S-hook of No. 13 music wire as shown in Fig. 6.

To assemble the model, slip two washers on the propeller shaft, with a minute drop of oil between. Thread the shaft through the bearing, slip the motor through the cans, and fasten the S-hook to the rear hook. Insert the fin and balance the machine on your finger. Slip the wing clips on the motor base so that the entering edge of the wing will be about 1 in. in front of the balancing (Continued on page 125)

Materials for the Model

1 pc. 3/16 by ½ by 45 in. balsa for motor stick.
1 pc. 3/16 by 3/16 by 45 in. balsa for motor stick cap.
1 pc. 1/32-in. balsa veneer for ribs and false ribs.
1 pc. 1/16-in. balsa veneer for center rib.
2 pcs. 1/32 by 1/32 by 16 in. balsa for entering edges.
2 pcs. 1/16 by ¼ by 16 in. balsa for wing beams, front.
2 pcs. 1/16 by 3/16 by 16 in. balsa for wing beams, rear.
1 pc. ¾ by 1 1/32 by 8½ in. balsa for propeller blank (or for a one-piece propeller, ¾ by 1⅜ by 16 in.).
2 ft. No. 11 (.026 in. dia.) music wire.
2 ft. No. 13 (.031 in. dia.) music wire.
2 sheets superfine Japanese tissue paper.
1 2-oz. can ambroid type cement.
1 2-oz. bottle of pure banana oil.
1 2-oz. bottle of light dope.
1 drilled bearing suitable for use with 10-strand rubber motor, or a small nail from which to make this bearing.
2 small washers.
38 ft. 1/16-in. flat rubber.
2 yds. fine silk thread.
Several long strips of bamboo (more than 12 in. between joints).

A Model for Long Flights

(Continued from page 124)

point. Sight the model to see that the fin is straight, both vertically and lengthwise, and that the wing has a slight additional angle in the right half.

Glide the model by launching it on an even keel at about its estimated flying speed; do this in a place where the model will not be damaged upon landing. If it dives steeply, move the wing forward; if it stalls and then zooms downward, move the wing to the rear. When a model glides at a uniform angle to the ground without stalling, the wing is approximately in its correct position.

As a final check before flying your model, weigh it and see how closely it approximates Shifler-Smith's model, the flying weight of which was 1.82 oz. With a regular 5-to-1 "egg beater" winder, put from 140 to 160 turns in the rubber. You will probably need someone to hold the propeller and steady the wing tips. You understand, of course, that the S-hook is removed from the rear hook and hooked on the winder and that the rubber is stretched out at the beginning of the winding operation. Gradually shorten the rubber as you wind until it is about the length of the motor base. Grasp the S-hook firmly, remove it from the winder, and hook it into the rear hook of the model. You may find it convenient to remove the fin while winding.

See that the rubber is evenly distributed along the motor base or it may catch slightly on the rear cans. This is very important in tractor models.

If the model is well adjusted, it barely climbs for five or ten seconds but then starts on a long, gentle climb. If the model climbs nicely at the very beginning of the flight, it probably will be overelevated at the end and there will be some loss in duration. Mark the adjustment points very closely and number them so that they can be located again. Even 1/16-in. difference in the wing location makes an appreciable difference in the flying qualities.

If the model circles to the left with the inside wing low, you will have to put more incidence in the right side of the wing. If it swings to the right and then to the left and back again to the right, it is an indication that you have too much incidence in the right wing.

For a contest or record flight the motor will stand from 230 to 270 turns made with a 5-to-1 winder.

A 15-in. propeller with about a 30-in. pitch may come in handy for flying the model in a fairly stiff breeze, but extreme care should be used in handling the wing on a windy day. A box for holding the model and the necessary extra parts and tools will be found useful.

Hammered Metal Bowls

(Continued from page 79)

every metal working operation, I have found it an advantage to keep the metal thoroughly clean as I worked it.

Place the disk centrally over the hollow in the block as shown in Fig. 7. Hold it firmly in position with the left hand and bring the hammer down on it, so that a dent or boss is made. Then move the disk slightly to one side of the center and strike another blow at the edge of the hollow made in the metal. Now continue around the edge of the hollow, moving the disk to convenient positions as you hammer. Continue hammering in a spiral fashion, making the blows come close together to stretch the metal down evenly as you work gradually nearer the edge of the disk (Fig. 4). Any flutes that appear on the edges of the disk should be hammered down as they occur.

While this process of making a bowl is very simple, care must be taken to keep the form symmetrical (round) as the bowl is being worked. Look it over (Continued on page 126)

Hammered Metal Bowls

(Continued from page 125)

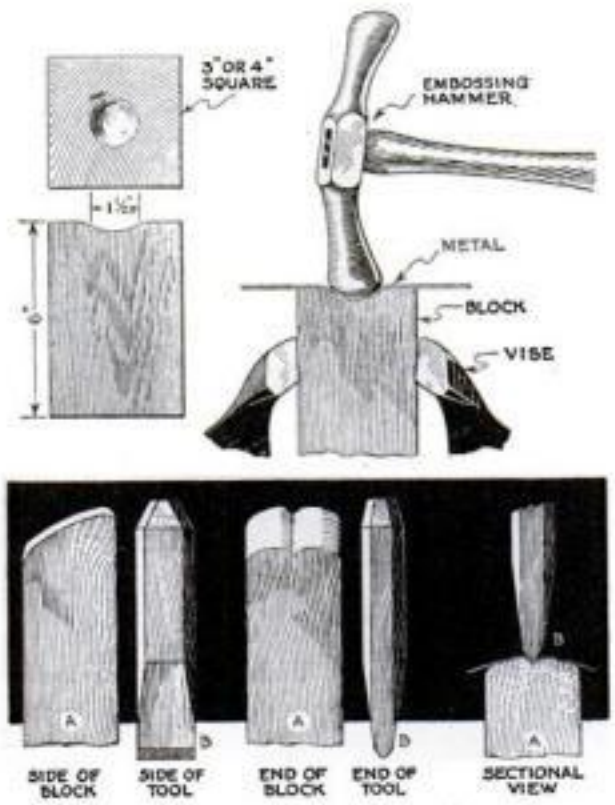


Fig. 7. Plain block used for making bowls, and shaped block and tool for decorating them.

carefully after each annealing and straighten it up before hammering further on it. If the bowl gets too much out of shape, it is almost impossible to make a good job of it.

After you have hammered over the entire surface of the bowl, you will have a shallow saucer shape. Anneal the work, pickle it, scrub it clean, dry it, and then start to hammer it in the center again, working out to the edge in a spiral of hammer marks. When you have stretched the bowl form in the center to the depth you wish, hammer around and around where you wish to enlarge or deepen the sides, starting a slight distance from the center to stretch the metal down to form a base for the bowl (Fig. 3). If you wish the sides to project more than the top or rim, hammer around and around just inside the rim to stretch the metal; always, of course, keeping the metal well annealed until the last hammering, after which it is not annealed, as it is desirable to leave the bowl "hard hammered" so that it may not easily be bent out of shape when finished. You will learn to govern the strength or force of your hammer blows so that the metal is hammered down evenly and smoothly where you wish.

All these bowls should, of course, have flat bases to stand on. A base may be formed in two ways. One method is to hammer the metal at the base of the bowl so that in the end it is stretched down flat. The metal may be still further flattened by *(Continued on page 127)*

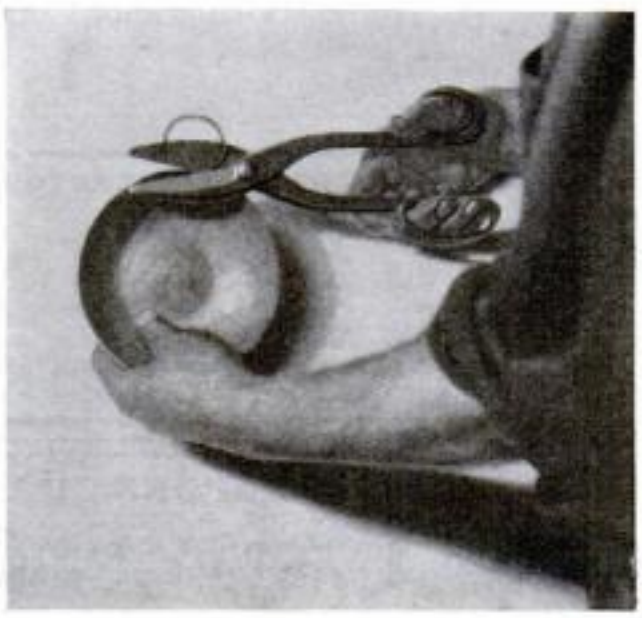


Fig. 8. How the bowl and shears are held when trimming away the excess metal at the edge.

Hammered Metal Bowls

(Continued from page 126)

setting the bowl right side up on a flat anvil surface and hammering it with a round wooden mallet with a flat end.

The other and somewhat simpler method is to hammer the bowl in a regular rounded bowl shape, either with no base or with a moderate flattening at this part. When the bowl is hammered to a suitable depth, place it upside down on a flat surface, find the center of the bottom, and scribe a circle of the diameter it is desired to make the base. With the same embossing hammer used to make the bowl, tap gently in the center until this sinks down below the base line and then hammer around and around this, working out to the base line, as shown in Fig. 5.

To trim off excess metal at the edge of the bowl after a base has been formed, set it upright on a flat surface and scribe a line with a surface gage around the edge parallel to the base and starting at the lowest point of the irregular edge (Fig. 6). If you have no surface gage, a good substitute may be made by driving a wire nail in the side of a square block,

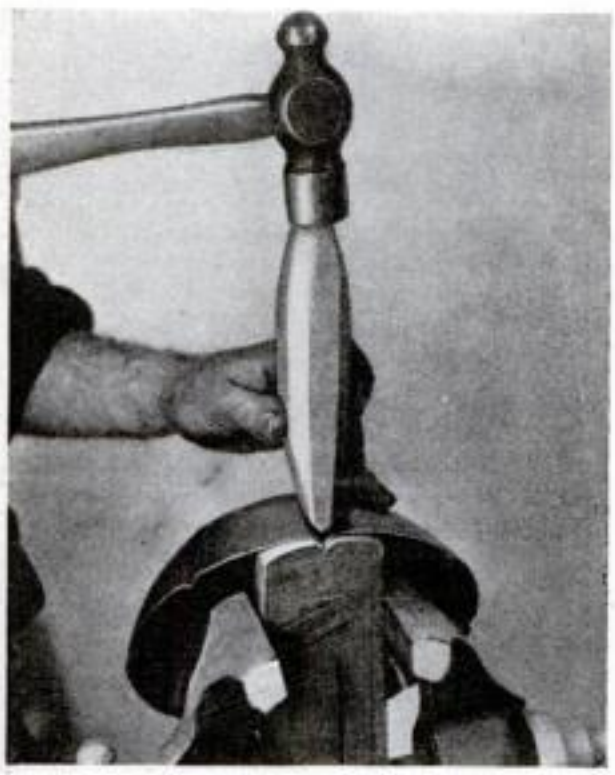


Fig. 9. Using a wooden forming block and tool to decorate the bowl shown in Fig. 2.

cutting off the head of the nail, and filing a sharp point on it. The point may be bent up or down as desired.

About the only way to trim off excess metal is shown in Fig. 8. Hold the bowl in the left hand with the open part *toward* you. Use a pair of straight shears and cut from *right* to *left*. If you have much metal to cut away, do not try to do so all at once, but cut off a narrow strip as you go around the edge, finally cutting carefully down the line. A flat file is used to smooth up the edge.

Sometimes a small bowl may be placed upside down on a sheet of emery cloth placed flat on the bench and the edge rubbed smooth. When the edge is smooth and flat, round it over with a half-round file and emery cloth so that the bowl will be pleasant to handle. Never leave sharp edges about your work.

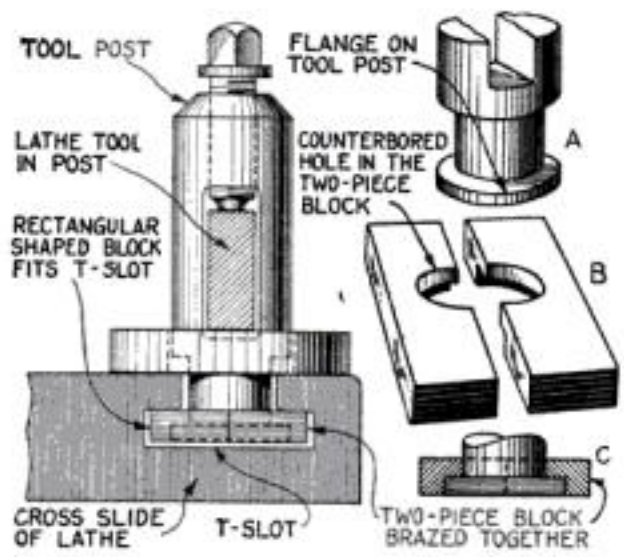
Figure 9 shows the process of making a bowl into a chalice or flowerlike form. After the bowl is hammered to a smooth shape, a wooden block is made as shown in Fig. 7. The end of this is filed with a wood rasp to fit the curve of the inside of the bowl, and then a fairly broad groove is cut or filed across the center of it. A wooden tool, shaped like a blunt cold chisel, is then made of hardwood, as shown in Fig. 7. The bowl is divided up in as many divisions as desired with pencil lines, not scribed lines. The block *A* is held in the vise, the bowl is rested on it, and the wooden tool *B* is used to drive the metal down into the groove in the block.

How to Make an Old Style Tool Post More Rigid

IN THE accompanying illustration is shown a lathe tool-post improvement that has been found satisfactory on lathes not fitted with a tool-post block of up-to-date design. As the improvement is easily made, it may be helpful to other machinists.

The form of tool-post construction used on many engine lathes is such that there is a rather poor bearing between the round lower end and the T-slot of the slide. Because of this limited contact the edges of the slot often wear away or break, and it is difficult to keep the tool post in position whenever a heavy cut has to be taken.

A block is made to fit the wide lower portion of the T-slot and bored as indicated by the dotted lines in the assembly view. The smaller bore is a working fit on the small lower portion of the tool post; the larger bore is a working fit on the enlarged head of the tool post, which is cut down to leave a narrower flange as shown by the dotted lines just mentioned.



Lathe tool post improved by the addition of a special bearing block at the lower end.

In making the block, two pieces of flat, cold rolled steel are used, which together form a piece wide enough to fit the T-slot. These pieces are lightly brazed together at the ends to hold them in alignment while the boring is done. Afterwards the pieces are separated by grinding away the brazing. Then the joint between the two pieces *B* is prepared for welding, placed about the tool post *A* in position for use as at *C*, and welded. When the improved post is fitted to the T-slot, it is ready for use.

This construction gives a full bearing between the tool post and the welded block and also between the block and the edges of the T-slot, thus making a very durable job.—EDWIN KILBURN.

Test for Ground Holes

IF THE grinding wheel is brought against the back side of a hole until it just sparks, then traversed the length of the hole, it will show whether the hole is perfectly straight by the uniformity of the sparks. This test, applied when the hole is nearly to size, may prevent spoiling a job.—H. J. C.

Glimpses of Men in the Public Eye

(Continued from page 20)

the largest mining properties in this country and in Mexico. He also lectured at Harvard, Yale, Columbia, and Johns Hopkins Universities. In 1911, President Taft appointed him special ambassador to the coronation of King George of England. The following year he again went to Europe as president of the Panama-Pacific Exposition Committee. From 1914 until 1915 he was chairman of the World Court Congress, and he served in the same capacity with the United States Coal Commission from 1922 to 1923. He now lives in Washington, D. C.

Magician of Chemistry

NOT long ago a client of Arthur D. Little, chemical engineer of Boston, was discussing the uselessness of a certain raw material.

"It's a waste of time to bother with that stuff," he said; "you cannot make a silk purse out of a sow's ear."

"Oh, can't I?" was the reply of Little.

Today a red and blue purse, for which the artificial silk was obtained by Dr. Little and his associates from the gelatin and tissues contained in a female pig's ear, is the star exhibit in the museum connected with the concern.

In a sense, that little purse is the symbol of Arthur D. Little's genius of accomplishing the "impossible" through industrial research. Among his recent amazing developments are processes for the manufacture of vegetable glue from starch, the recovery of turpentine and resin from yellow pine stumps, and the extraction of zinc from complex ores.

Dr. Little has worked out more processes of paper manufacture than any other chemist in the world. Only lately he developed a practical method for making newsprint paper from Southern woods. When operated on a large scale, it promises an enormous reduction in the cost of newsprint.

He is the inventor of processes for the manufacture of chrome-tanned leather and artificial silk, and has directed the production of a long line of alcohols and special products from petroleum.

Dr. Little is now sixty-five years old. His interest in chemistry began more than half a century ago, when he was a public school boy in Portland, Me. One day a boy seated back of him in the classroom nudged him and whispered:

"Arthur, have you a dime?"

Little inspected his pockets and discovered just ten cents.

"Lend it to me," the boy whispered again, "and after school I'll show you some chemical experiments!"

Young Little made the investment. With the dime, the boys bought a piece of glass tubing and five cents' worth of sulphuric acid. For the first time, Little saw sulphuric acid reacting upon zinc and producing hydrogen—but he heard it, too! The generator had been improperly set up and exploded, but without damage.

That evening he informed his parents he was going to be a chemist. They sent him through preparatory schools, and later enrolled him in the Massachusetts Institute of Technology.

His first job after leaving college was that of part chemist and part clerk with a paper mill near Providence, R. I., at two dollars a day! Six weeks later he was superintendent of the mill, which was the first in this country to make sulphite wood pulp, and when he quit, his salary was $2,200 a year. But he wanted to be his own boss; so, with another chemist, he started a consulting chemists' laboratory in Boston.

The Little laboratory was on the sixth floor of a dingy building in a little side street and its equipment was scant. (Continued on page 130)

Glimpses of Men in the Public Eye

(*Continued from page 129*)

In those days, the fee for a sanitary analysis of water was five dollars and the top price for analyzing a sample of sugar seventy-five cents. At the end of the first year, the partners divided $600!

But they refused to quit. Their enthusiasm was justified, for a few years later the firm began to prosper. Then Little's partner was killed in a laboratory explosion. He carried on the business with another associate, who withdrew in 1909.

Since then, the firm has been known as Arthur D. Little, Inc. Today it occupies a palatial three-story structure. Not the least interesting feature of the establishment is a series of part-size plants, including a pulp and paper mill and an oil refinery. Industrialists in all parts of the world are among the clients of the laboratory.

Little has served both as president of the American Chemical Society and of the American Institute of Chemical Engineers. Recently, he was elected president of the Society of Chemical Industry of Great Britain. He holds the honorary degree of Doctor of Chemistry from the University of Pittsburgh.

Father of the Skyscraper

NEARLY half a century ago L. S. Buffington, a young Minneapolis architect, patented the idea of the skyscraper, or "cloud-scraper," as he then called it. The other day, in his eighty-first year, he received his first royalty on the skyscraper patent, and that despite the fact that the patent had run out!

It was a check for $2,250, one eighth of one percent of the cost of the new twenty-six-story Rand Tower in Minneapolis. It was signed by Rufus Rand, a young capitalist who is something of an inventor himself and who, in this manner, paid a belated tribute to the man who visioned our modern towering structures.

Buffington's invention was a braced skeleton of steel with a steel shelf at each floor to hold the masonry veneer. He conceived this idea in 1880, at the age of thirty-two. But it was not until 1887 that he found time to apply for his patent, which was issued the following year.

In 1892 he drew the plans of his first "cloud-scraper"—a twenty-eight-story building. His contemporaries called him an impractical dreamer.

In the nineties the inventor formed a company to protect his patent. But tall buildings were going up in many cities, and the company started numerous suits. These dragged on for many years, until, at last, the patent had run out. Buffington spent a small fortune trying to collect royalties.

BORN in Cincinnati, Ohio, Buffington started his career as a draftsman with a railroad. His leanings, however, were toward architecture, and in 1869 he went to Minneapolis, then just emerging from its frontier settlement stages. Some of the largest buildings of the early days in Minneapolis were his conceptions, including the old state capitol of Minnesota, several of the buildings on the University of Minnesota campus, and the famous West Hotel, which still stands.

In not a few of these structures did his skyscraper ideas enter. In 1880, when he erected the Boston Block in Minneapolis, he used more cast iron and I-beams than was customary at the time, though it was only a seven-story building. In the West Hotel he built the stories of I-beams, with girders across the second story.

Though he has never really reaped the fruits of his invention, Buffington has remained an optimist. His advanced years and even severe eye trouble do not prevent him from spending part of each day at his (*Continued on page 131*)

Glimpses of Men in the Public Eye

(Continued from page 130)

drawing table. A small, wiry man with snow-white hair and beard, he sits in a room decorated with photographs of more than forty large buildings he has designed. Through the windows he proudly watches the changing skyline of his city, with the steel and masonry buildings of twenty-five, thirty, and more stories that he dreamed of and put on paper nearly fifty years ago, at last coming into being.

He Makes the Camera Lie

ONE afternoon a few weeks ago a man rang up Lejaren Hiller at his photographic studio in New York City and inquired:

"Can you give me a photograph by noon tomorrow of a council of nations sitting in the shadow of the Pyramids with the Sphinx in the background?"

"Sure!" Hiller replied. "Do you want a lot of pomp and military regalia?"

It was an easy task for Hiller—merely a matter of sitting down to his workbench and making the Pyramids and the Sphinx in miniature out of modeling clay, selecting models to represent national leaders and military figures, calling on his property room for the necessary costumes, and then focusing his camera. Two photographs were made. One showing the group of personages was superimposed on that of the clay models; the combination was re-photographed and retouched, and by noon the next day the order was filled!

Hiller, inventor of "creative photographic illustration," does things still more amazing. His work is a continuous contradiction of the old saw that "the camera never lies."

He invented his process twenty-one years ago. A native of Milwaukee, Hiller made a comfortable living as a magazine illustrator. In his leisure, he experimented with photography. One day the idea occurred to him that, by combining painting and sketching with actual photography, he could get more realistic illustrations. In New York at the time, he was told by editors that the "stunt" was impracticable. One of the skeptics, a friend of Hiller's, tossed him a story calling for an illustration of the villain standing beside a cactus, with the Rocky Mountains in the background, and demanded to know how Hiller was going to photograph this scene in the city.

Hiller took a picture of a building excavation. Then he found a villainous looking man to serve as model, dressed him in cowboy clothes, and photographed him. The picture of the excavation he turned upside down, giving a perfect effect of a cave. Thereupon he superimposed the photo of the bad man on that of the "Rockies." The editor was delighted. Hiller's success dates from that day.

Soon business concerns caught the idea and began to order illustrations for advertising purposes. Since then, Hiller has been busy with camera, models, brushes, paints, and modeling clay, turning out "creative photographs" for calendars, posters, booklets, and other advertising material. The subjects of his "photos" range from Commodore Peary discovering the North Pole and the pioneers of '49 crossing the desert in covered wagons, to Santa Claus making a triumphal entry in his reindeer sled on the asphalt of Fifth Avenue.

The World's Strangest Zoo

SOME of the best four-footed friends a man ever had pass their lives in a great American institution of scientific research. How dumb animals are helping valiantly in the fight against dreaded human diseases will be told in a remarkable article in next month's issue.

The Man Who Made Radio Talk

(*Continued from page 32*)

kept young De Forest going. He had a strong natural bent for mechanics; he was going to be a mechanical engineer. But electricity was looking up. The war between alternating and direct current had been fought and compromised. Electric railways were spreading all over the country, Niagara was being harnessed for power, one could telephone a hundred miles, every big town had its arc lights in the streets. De Forest read everything he could get hold of about electricity, absorbed all that his professors at Sheffield could give him. He was looking ahead. What was to be electricity's next step? Where could a youth on the threshold of life find his best toe-hold in this field?

TO GET means to pursue his experiments and his education, he worked for a time, after graduating with the degree of B. Sc. in 1896, for the Western Electric Company in Chicago, the largest makers of telephone equipment. The Spanish war came along, Yale men organized the "Yale Battery," Battery A of the First Field Artillery, Connecticut National Guard, which saw service in Cuba and in which De Forest served as a gunner. Then he went back to Yale for post-graduate study and the degree of Ph.D.

Great things had happened in electricity. Hertz, in Germany, had discovered that electrical impulses travel through the "ether" without wires. Tesla had startled the world by lighting an electric lamp at a distance, wirelessly.

There is a streak of mysticism in Lee De Forest, a fondness for the occult and the unknown. Here was something which appealed intensely to the introspective, mystical-minded youth to whom the world was still a fascinating storehouse of unexplored mysteries. Electricity without wires! The very thought made him tingle.

"I would get a job with Tesla, if there were any possible way to do it, I decided," he told me. "But just then a book fell into my hands which described Marconi's early work in wireless telegraphy.

"*There* was the new, unexplored field—the field of communications. That was where the Hertzian waves could be made useful, if anywhere. I knew that I had found my niche in the scheme of things."

HE STUDIED wireless until he felt that he understood it as well as anybody did at that time. Marconi came to America in the fall of 1899, set up his antenna on Sandy Hook, and reported the Shamrock-Columbia yacht race by wireless from a tug. De Forest saw the Marconi apparatus.

Marconi's method of detecting radio impulses was by means of a device called the "coherer." This consisted of a small glass tube containing two closely fitting silver cylinders with the small space between their ends filled with a mixture of nickel and silver filings in the proportion of about 20 to 1. The air was exhausted from the tube to prevent oxidization. When a radio wave passed through the filings, they "cohered," or stuck together, permitting current to flow from a battery circuit, which operated a bell buzzer. The clapper attached to it continuously tapped the coherer, thus breaking the filings apart when the radio waves stopped. De Forest decided at the very start of his work in wireless that he would find a better way of detecting the waves.

Some of De Forest's critics have contended that his audion tube, which was the result of his search for a better detector, was merely an adaptation of the Fleming valve. Some of the infringers on his patents set up the Fleming valve as their defense. Professor J. A. Fleming, of England, recently (*Continued on page 133*)

The Man Who Made Radio Talk

(Continued from page 132)

knighted by King George, discovered that by heating a filament in a gas-filled bulb, providing a second electrode in the form of a plate to which the electrons given off by the filament could flow, he had a valve which would convert alternating current into direct, as it would let the electrical waves flow through in only one direction. De Forest's audion tube introduced a third electrode, the grid, between the filament and the plate, and made the Fleming valve into an extremely sensitive wireless detector.

But De Forest told me the other day he had never heard of Fleming or his valve when he set forth on the road of research which led to the audion tube. It was an amusing accident which set him on the trail of the conduct of heated gases as a possible answer to his problem.

HE SET up a little laboratory in Thames Street, New York, where he began to hunt for a substance, a device, or a method which would pick up wireless waves. There were batteries and a Ruhmkorff coil in a closet, connected with the worktable by wires and a button to set off the discharge. The experimental detectors were tried out by means of a telephone receiver, to detect the "click" of the discharge, if it were detectable. The noise of the spark from the closet made detection a matter for keen ears.

"There were no headphones then, so I had to hold the receiver to my ear with one hand, manipulate the detector with the other, and press the button with my knee," De Forest told me, smiling reminiscently.

"I got hold of a report of the work of a German electrolytic experimenter who seemed to have something which might work. I followed up his work and produced what I called a 'responder.' It would work, uncertainly, for half an hour or so, and then go dead."

An accidental observation seemed to put the young experimenter on the right track. The only light in the room came from a gas jet equipped with a Welsbach mantle. One night De Forest noticed with surprise that whenever he pressed the button, causing an electrical discharge, the gaslight grew dim.

He tested this effect again and again. It worked every time.

Later with his roommate and coexperimenter he repeated the experiment. The discharge of the coil clearly seemed to affect the combustion of the gas in the burner. De Forest started at once to work out on paper a theory of the properties of heated gas in detecting wireless waves.

THE next day the young experimenters tried again, this time with the closet door closed. Nothing happened!

They opened the closet door and the gaslight waned again with every discharge. They closed the door, and nothing happened.

"It was made painfully evident that the effect I had been so wildly excited about was an acoustic effect which had nothing whatever to do with electric waves," De Forest told me. "My associate became disgusted and quit the experiments. But the theory of heated gases which I had worked out seemed so plausible and full of possibilities that I kept on along those lines and finally got what I was after."

With the aid of a Bunsen burner he first got the effect which he had reasoned out, but to be of practical value the gas must be heated electrically. He tried experiments with an arc lamp, found that it could be used as a detector, but was frightfully noisy. Some way of utilizing the heat given off by a filament inside of an incandescent bulb had to be found.

"I had a lot of trouble getting the vacuum in the bulbs right," he said, recalling those early days of disheart- (Continued on page 134)

The Man Who Made Radio Talk

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ening experiment. "At last I enlisted the aid of a maker of miniature incandescent lamps and we made bulbs with filaments of platinum, of carbon, and of tantalum. Tungsten had not yet been thought of for this purpose. Those early tubes resembled Fleming's in that they had both the filament and the plate, but I had a battery connected in series between the filament and the plate, which Fleming never had."

At last he had found what he had been seeking, a radio detector which not only served as a detector, but as a relay and an amplifier, as well. The American De Forest Wireless Telegraph Company, first to utilize alternating current generators and transmitters, was formed in 1902, the year in which Marconi got his first signals across the Atlantic.

The pupil was ahead of his master!

THEN came his work for the Government. He built the first five high-power wireless stations for the United States Navy. He kept plugging away at the improvement of his tube. What would happen if he added a third electrode?

He tried it, first with a strip of tin foil around the outside of the bulb, then with a grid between the filament and the plate. Here at last was the most delicate detector yet devised.

A weak electric voltage applied to the grid of the tube acted as a "trigger" to release a much larger flow of electrical energy in the plate circuit of the tube. The tube actually amplified electric currents by adding the power from a separate battery. And by properly arranging the circuit, De Forest found that the grid permitted him to feed smooth, direct current into the tube and obtain from it alternating current at any desired frequency.

The "trigger" amplifying action was adopted by the great telephone systems and made possible the renewal of the energy in long telephone lines as many times as was necessary to overcome the losses in over 4,000 miles of wire. You could talk from Boston to San Francisco.

And the oscillating feature of the tube made it possible to pump a steady stream of radio waves into an antenna.

Radio began to talk!

By the time the United States entered the war, in 1917, our Government had something no other nation possessed, a wireless telephone system which could be used between an airplane and the ground, from point to point over land and sea, from ship to shore and shore to ship. And the credit for that, as the United States Supreme Court has just declared, is all Lee De Forest's.

THE war over, radio took its next great step forward, a step which De Forest and his wireless telephone had made possible—broadcasting. And De Forest turned to other things.

He had made the radio talk; why not make the movies talk? Dozens of inventors were trying to do that. Nobody had thought of what seemed obvious to De Forest. By means of his audion tubes it was easy enough to make a light flicker in response to a human voice. If he ran a strip of photographic film in front of such a flickering light, the record on the film would be a photograph of a voice—of sound.

To translate the picture thus made back into sound again seemed simple to him. Just reverse the process. Instead of a light, set up a photo-electric cell in front of the film. As the alternately dark and light bands recorded by the voice passed in front of the cell, they would cause oscillations in the current passing through the cell. Pick up that current, amplify it, run it into a loud speaker, and you would hear the picture talk.

So De Forest reasoned and so he did. The De Forest Phonofilm, (Continued on page 135)

A definite program for getting ahead financially will be found on page four of this issue.

The Man Who Made Radio Talk

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parent of the talkies, was born, and to its production and perfection he has devoted all of his experimental effort for the last eight years, until now the talkies have come into their own and the big laboratory in East Forty-Eighth Street is rushed to produce apparatus for making and reproducing talking films fast enough to supply the demand.

"What are you going to do next?" I asked.

"I have no definite plans ahead," he replied. "I am interested in what we are doing here, and in what others are doing in the radio field. I have been watching the experiments with television with considerable interest."

"What is going to come of them?" I inquired.

"I THINK within two or three years we shall see television on a small scale being broadcast and received quite generally," he said. "It will be a long time, if at all, before we have it on any large scale. There is only a comparatively narrow carrier wave-band available. The larger the area to be covered by the transmitted picture, the higher the frequencies required. That brings us down into extremely short waves, a meter or less, which are absorbed by buildings.

"It would be much easier to show a life-size television scene in the open country than in the city, for that reason. But the people live in cities, and radio must be brought to them. So I am skeptical about anything beyond small-sized images now being successfully shown by television."

"What are the other tendencies in radio?"

"I think it is going to be more and more useful for its original purpose, that of communications," was the answer. "The facsimile method of transmitting messages is slowly but surely coming into use. When the public wakes up to its advantages it may supersede all present telegraphic methods.

"I believe, too, that we shall see a great extension of the use of short waves, up to thirty meters or so, for communications. Everybody in the beginning went after longer and longer waves and more and more power at the transmitting end. Now we are working in the other direction. Marconi has got surprising results, and improvements are going on constantly. I think we shall soon see newspapers, for example, using short-wave point-to-point wireless for transmitting not only news and pictures but facsimile advertisements and the like.

"A CHAIN of newspapers might transmit whole pages of news in facsimile to all the offices in the chain, and I believe something like that is being considered by some of them.

"Beyond that I would not care to venture any predictions."

Time has left its mark on Lee De Forest. He looks older than his fifty-five years. But his enthusiasm has not waned, and while he has overcome a good deal of his youthful diffidence he is still shy, gentle, modest, and unassuming. He has a modest man's pride in the honors which have been bestowed upon him, the Elliott Cresson medal of the Franklin Institute, the degree of Doctor of Science from his alma mater, the gold medal of the Institute of Radio Engineers, and a dozen others. One of the things he has done with the wealth which has come to him from his inventions is to establish at Yale the De Forest radio library, containing everything published in any language on the subject of radio, and the De Forest lecture course, given by the foremost men in the field, eight or ten of them a year.

And I think that perhaps what Lee De Forest is most proud of is a little booklet issued by Yale University in which his own name is coupled with that of another famous Yale graduate, Dr. Samuel F. B. Morse, inventor of the electric telegraph.

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copyist had been aloft more than half an hour. The same day Orville gave Lieut. F. P. Lahm—now brigadier general—a short passenger trip, and was warmly congratulated by Secretary of War Wright, General Miles, and other officials.

While near-plane pilots abroad togged themselves in fancy flying garb, the inventor sailed in his business suit, cap, and low shoes.

With Lieut. T. Selfridge, assigned as passenger at his own request to the War Department, Orville on September 17 embarked upon the one disastrous flight of his career. He and his passenger were laughing as their craft rose late in the afternoon and began to circle the field. Laughter froze on their lips within a few seconds. The pilot heard an ominous tap-tapping. He glanced back and found that control of the vertical rudder was gone. A cracked propeller blade had snapped the rudder wire. The machine wabbled for a crash on the bank of its fourth circle, 150 feet up. Orville lived hours in part seconds. He tried to balance by warping alone. By lightning-quick action he leveled the craft for a down glide, but had only seventy-five feet left. Moreover, the front rudder was now defective.

"GIVE me twenty feet more!" moaned his agonized brain.

"Oh!" cried Selfridge, grasping a strut at the last fatal dive of the plunging machine.

The Army officer died within a few hours. Orville suffered broken ribs and a fractured left leg. Sleepless through four days and nights of torment, the inventor was soothed in the military hospital by the presence of his sister Katharine. His first words as he lay stricken on the ground had been:

"Tell my sister I'm all right."

Four days after the accident Wilbur in France made a world's duration record of one hour and thirty-one minutes, and as he stepped from the plane remarked:

"This will cheer Orville up a bit."

It did indeed! It calmed the torments and brought the first sleep in ninety-six hours. Wilbur's feat across the ocean was triumphant proof to the world that the disaster at Ft. Myer did not imply futility of the airplane nor impair the future of aerial navigation. Besides this tribute and testimonial, Wilbur, fulfilling the French contract, cheered his convalescing brother by cabling home several thousand dollars. The cash was badly needed, what with a mortgaged home, a father retired from the active ministry, all savings spent, and the hope of payment from Uncle Sam indefinitely postponed.

WILBUR, preparing to fly at Le Mans that summer, was his own chief mechanic and cook. It was suggested that he put ball bearings on his propeller shafts. He replied dryly that since he could not make them himself and would not trust the job to anyone, he would try to get along without this feature. His bedroom was a fair sized packing case within his shed hangar and the furniture consisted of a cot, a wash stand, and a camp stool. He made his own breakfast on an oil stove. A piece of hose attached to a water pipe comprised the bathing facilities. Eminent visitors did not interest him but his "face lighted up and flushed with pleasure" when sincere and intelligent callers praised his work.

The French were captivated by the magical feats of the air-riding Yankee and intrigued by his austere personality. He kept the Sabbath, avoided women, abstained from tobacco, wine, and even choice food. What a man! Poets extolled him as a medieval knight. The peasants, viewing Wilbur and his craft with awe, made pilgrimages to Le Mans as though it was a shrine. Hawkers on the streets of Paris sold innumerable picture (*Continued on page 137*)

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post cards and statuettes of the American, including portrayals of him as a Billikin in flight. Today a monument to him stands at Le Mans.

At Auvours field on December 31 Wilbur broke another record, making seventy-seven miles in two hours and twenty minutes, which brought him the $4,000 Michelin prize and trophy. Austere and taciturn as he was to the public, Wilbur wrote home with gay freedom, telling about his gold medals "about the size of a small can."

Orville, having spent seven weeks in the hospital, sailed with his sister for Europe in January, 1909. Katharine had the exciting job of "social manager" to her brothers. Perhaps knowing by intuition that there would be a lot of kings ahead, she laid in a couple of the best evening gowns that Dayton could supply, and added a trifle to her wardrobe in Paris.

PAU, a winter resort in southern France, became the scene of the Wrights' activities and the focus of all continental eyes. The town gave the pioneers a field, hangar, and free quarters in a hotel with a French chef thrown in. Somehow the brothers did not take to the chef's delicate art and soon retired to rough it comfortably at the field, leaving Katharine at the hotel. Orville's health improved so that he could help his brother while still unable to fly himself. His courage was unshaken by his tragic accident.

Wilbur played the school teacher at Pau, giving an unprecendented course in pilotage of a new vehicle to persons designated by the French Wright company. There were no textbooks on the subject, none of the modern elaborate devices now used in ground school to test the pupil's senses, scramble his insides, and give him safe practice. Professor and pupil exchanged a few remarks, then rose in the air and took a chance. Yet no one was hurt in any of the three dozen teaching trips. The honor of being the world's first flyers taught by the Wrights was shared by Count Charles de Lambert, Paul Tissandier, and Captain Girardville of the French army. The brothers considered de Lambert their best friend abroad and were delighted by the favors of his six-year-old daughter who termed Wilbur "*My* Mister Wright" and Orville "Best Orville."

THE King of Spain arrived in February. He sent word ahead requesting an exhibition flight on Sunday. Everybody knows that a royal request is a command. But the Americans, whose father was a minister, politely replied that they would be pleased to entertain His Majesty on any week day. The king changed his schedule to suit while the populace brought out their flags.

Alfonso romped into the hotel dining room, followed by suite and bodyguard, on a Friday night. Katharine was flustered, and relieved that she escaped the royal eye, not being attired in either of her evening costumes.

After shaking hands with the brothers at the field early next morning, the Spanish ruler called for their sister. Katharine had just been tutored by Lady Northcliffe, wife of the English newspaper owner, on how to make a curtsy, but decided on the spot to be herself. So she left out the curtsy and gave a friendly hand to the monarch, who responded with beaming smiles and compliments and told again how the veto of his queen and cabinet deprived him of an ardently desired trip in the air. He spoke fluent English.

As Wilbur landed from a flight, the excited young king ran and jumped over obstacles to reach the machine. Sitting in it beside the inventor he volleyed scores of questions and showed that he understood a good deal of the problem involved (*Continued on page 138*)

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(Continued from page 137)

in aviation. Afterward the Wrights had lunch with the king at a hotel. Leaving town next morning, the Spanish ruler went out of his way to shake hands with Orville and Katharine, and to salute her with raised hat.

The airplane was launched at this time by a derrick weight, which had to be hauled to the top by a rope before each flight. There was keen competition among the high and mighty of Europe, assembled at Pau, for the honor of pulling on the rope. Those who were not allowed to heave felt it a privilege just to put their hands on the rope. Among those who participated in the hauling ceremony were Arthur Balfour, who had been Prime Minister of England, Lord Northcliffe, and the Duke of Manchester. Half a dozen years before at Kitty Hawk, the inventors had paid a man $1.25 per day for exerting his muscle on the virgin flyer.

SOME of the worshipful notables envied the job of the Wright mechanic at Pau who solemnly prepared the plane for each ascent by walking up to it from behind and giving the tail a brisk wiggle. It was agreed that the wiggle was an essential detail, but being a simple act should not have been monopolized by a selfish mechanic.

"Where's the Comtesse de Lambert?" said Wilbur one evening as twilight began to fall from the crests of the near-by Pyrenees.

"Mr. Wilbur wants *me*? He cannot want me but for *one* thing!" exclaimed the moist-eyed countess ecstatically, returning to the field. She had not told anyone of her dearest wish, now to be fulfilled.

The silent American smiled at his friend's wife and deftly tucked her into the seat. As the plane came back to earth she was speechless with delight.

Wilbur next treated his sister to her first jaunt in the sky. Despite all her familiarity with the machine, going back to the days when it was just a dream subject debated by her brothers in the home living room, she had the thrilling emotions of a novice undergoing a marvelous adventure. A little dazed and bewildered when the roaring craft left the earth, she was fearless because Wilbur was beside her.

AT NEWS that the King of England was coming, a host of his loyal subjects besieged the Wrights with letters, wires, phone calls, and personal visits. There were hundreds of messages from baronets, noble lords, belted earls, and other personages of the first rank. Many of these had no desire to hazard their necks by a trip aloft. They merely regarded the airplane as a social elevator and wished to be accorded their proper places in the royal picture.

King Edward VII arrived on March 17. The inventors and their sister were presented to him at the field. Katharine shook hands with His Majesty, who spoke pleasantly. He was a stout figure with a pointed white beard, passing into age and weariness. The brothers explained their vehicle to the king, who listened with courtesy but did not seem to have much interest in mechanical details.

Wilbur made a flight in the royal presence and on landing said to his sister:

"Sterchens, don't you want to climb in?"

Katharine replied she couldn't because of her large hat, whereupon Orville, grinning, stepped forward with cap and veil as prearranged with his brother. Thus the delighted Katharine had her second and most gorgeous flight before His Britannic Majesty and over the heads of peasants strewn along the countryside in gay Mardi Gras costume.

"See, a woman flies also!" cried the peasants, waving hands and bright headdresses.

But the occupants (Continued on page 139)

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of the magic car floating toward the snow-capped mountains soon forgot the lesser spectacle below. A man who had mastered the air looked at his passenger, playmate of childhood and woman he loved best, and nodded meaningly toward the sparkling Pyrenees as though to agree that life had been perfected and the last goal attained.

The Wrights were in Rome in Good Friday week to make flights and deliver a plane to the Italian government.

Their hotel boasted of "central heating," despite which the rooms were a bit chilly, and Wilbur remarked:

"Guess what we want is local heating."

After he was more conveniently housed in a cottage near the flying field, Wilbur messed frequently with Italian officers and reported to his folks that he had made a record by devouring "forty-seven miles of macaroni."

The elder brother had arrived in Rome some days before Orville and Katharine, and was to be presented immediately to the King of Italy by the American ambassador.

"THREE bows will be suitable for the occasion," advised Ambassador Griscom in a note.

"I didn't know," commented Wilbur later, "whether it meant to wear one under the chin and one under each ear, or whether it meant to make three of them to the king at the presentation."

Assuming that obeisances rather than triple neckties were required, Wilbur started to perform before Victor Emmanuel at the palace.

The tall, lanky American tilted once. He was halfway on the second bend when the short little monarch pushed him cheerfully into a chair and, taking a seat himself, began to talk in plain English, asking questions and making simple but pointed comments. There were no frills on His Majesty. While he showed less enthusiasm than the effervescent Alfonso of Spain, he had more interest in the airplane than the King of England.

Mr. McMahon's story of Wilbur and Orville Wright will be concluded in next month's issue, in one of the most absorbing chapters of all.

First after the Wrights

AN OBSCURE Frenchman and an almost unheard-of Dane are given leading places in a list of the world's thirty-six "first aviators," pilots of powered planes, recently completed by the Aeronautics Branch of the Department of Commerce. After Wilbur and Orville Wright, numbers one and two, respectively, on the list, come "T. Vuia, France", third, and "Ellehammer, Denmark," fourth.

Despite the credit generally given the Brazilian aviator Santos-Dumont as the first to follow the Wrights, actually the first was the Frenchman Vuia, according to Maj. Ernest Jones, of the Aeronautics Branch. Records he has examined show that Vuia made a short flight of about forty feet at Sartrouville, France on March 18, 1906, in a miniature tractor monoplane propelled by a "carbonic acid gas engine." Later, with a modified plane, he made a number of short hops, which ended with a crash on July 5, 1907.

At Holm, Denmark, on Sept. 12, 1906, J. C. H. Ellehammer made his first cautious flight of about 140 feet. His monoplane was powered by a motor of only nine horsepower, curiously resembling the radial motors of today. By February, 1908, he had succeeded in covering nearly a quarter of a mile. In June, 1908, he made a number of 300-foot flights and then dropped completely out of air history.

I Am Learning to Be a Flyer

(Continued from page 28)

Very crisply came Jordanoff's voice: "We will have to land. This motor is bad. Release the controls entirely." I did so. I looked down. On one side of us were thick woods. On the other was a thick tangle of roads and houses. Between was a long, rectangular field.

The motor sputtered again. I knew that we were about to make a forced landing. How many times had I read that headline:

FAULTY MOTOR FORCES FLYERS DOWN!

But I was not nervous. I had confidence in Jordanoff. In war and peace, he had flown 3,000 hours.

His head was moving rapidly from side to side. Suddenly the nose went down and the right wings pointed at the ground. The ground came rushing up to meet us. We straightened. Then the left wings went down and again the ground came rushing up to meet us. Again we straightened.

WE SEEMED to float along behind the idling motor. The ground was suddenly within reaching distance. We skimmed over it. There was a gentle bump—a perfect three-point landing! (A three-point landing is one in which both tires and tail skid touch the ground simultaneously.) We coasted to a stop.

Jordanoff turned around, smiling. I asked: "Was that a side-slip landing?"

He answered: "Yes. It was necessary. Even if we had had enough room to glide in, the wind was wrong. Whenever possible, you always take off and land into the wind. Because of the shape of this field we had to land across the wind. If the wind had been strong enough, we might have washed out our landing gear. Did you notice this field when the motor began to sputter?"

I had not. In fact, so far, while in the air, the ground had been a meaningless confusion. I had fixed my eyes on the radiator and watched the wings out of the corners, to see that I was flying with the horizon where it belonged and that the wings were level. Only when necessary had I torn my eyes from the nose and wings to look down at the landmark I was steering for. It generally takes a student a half dozen lessons, I learned, to become "ground conscious."

JORDANOFF continued: "It isn't pleasant to be forced down by a bad motor, but this will teach you an important lesson. Always have your eye on a possible landing field. When that motor began missing, we were above this field. We could have flown on and taken a chance of finding another field. But you must never do that. There might not be another field.

"Sometimes a sputtering motor merely means a little water in the carburetor, which may run through in a few seconds. But it may mean more serious trouble. If your motor starts sputtering or missing and you are over a good place to land, start circling about it. If your motor dies, you can land. If it stops sputtering and settles down to work again, you can fly on. It pays to be careful.

"Every good flyer," Jordanoff went on, "is a careful flyer. This is the one business in which a man often does not live to correct his first bad mistake. That may sound fatalistic. All laymen have the feeling that the life of a flyer hangs by a thread. This is an exaggerated idea. A flyer simply must get it into his head that he is not to make any mistakes. Every experience a flyer has, every contingency he meets, makes it easier for him to be careful. Therefore, the longer he flies, the safer he is in the air. Don't get it into your head that, after your first solo, you are a finished flyer."

I had heard that before. In fact, I had heard it at least a dozen (Continued on page 141)

I Am Learning to Be a Flyer

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times before, from a dozen different pilots and students.

Jordanoff continued: "Charlie Collyer used to say: 'Be yellow and last long.' I was looking at a recent Department of Commerce analysis covering six months of airplane accidents. More than forty percent were due to errors by pilots. Every one of those accidents might have been prevented if the pilot had exercised greater care. Most students think it is a disgrace if they don't solo before their tenth hour of instruction. That attitude is foolish and dangerous."

A few days previously, I had heard Charles Gaver, the school manager, saying to a man who was making inquiries about courses:

"I wish all flying schools would discontinue the ten-hour course. It appeals to people because it is cheap. But it's too short. It gives the average student one or two solos. He goes away thinking he can fly anything. He is a menace to himself and everybody else."

HIS and Jordanoff's comments were brought home forcibly to me a few days later when Martin Van Voorhis, one of the students, was killed—the first student fatality of the 2,000 who have gone through Curtiss. No expert saw the accident, but it is presumed that "Van" was flying at 2,000 or 3,000 feet, got into a tail spin, and could not get himself out of it. His death was a great shock to all of us who knew him. He had been soloing four hours.

It would be unfair to say that Van died because he soloed too soon. No one knows or ever will know. But pilots with whom I talked all drew from that accident the same moral: A student should not be too anxious to solo. "Be yellow and last long." Some pilots go so far as to say that a student would profitably fly with his instructor twenty-five hours or even longer before he soloed. But many students cannot afford to do that. There is, on the other hand, a strong argument in favor of early soloing: It makes the student self-reliant, and gives him self-confidence.

UNTIL he makes his first solo, he is apt to depend too much on his instructor. The more conservative instructors recommend a reasonably early first solo—a very short one—followed by a period of instruction flying, then more solos and more instruction flying—as many hours as the student can afford.

Everyone, however, agrees on one golden rule: The longer you fly, the safer you are.

The morning that Jordanoff and I made a forced landing in the rectangular field seems long ago. But I have not forgotten that it took him a half hour to adjust the motor that somebody less careful had checked out as O.K. We took off and flew back to Curtiss Field. The lesson was over. And I had several more items to jot down under the notation, "Be finicky."

ROAR of the motor, the blast of wind on your cheek—can't you imagine yourself in the cockpit with Larry Brent, touching the stick with your finger tips, learning to fly?

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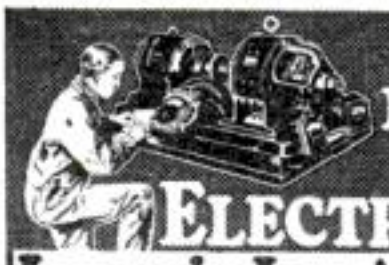

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Comfort Behind Brick Walls

(*Continued from page 75*)

instead of the shingles or siding a four-inch brick wall is built. The bricks are held to the wall by driving spikes into the sheathing about every four courses of bricks and letting the nailheads be completely embedded in the mortar joints. To all appearances the construction is that of a solid brick wall.

This brick veneer construction has the good qualities of a wooden house but with a permanent outside covering.

Another form of veneer is to apply the four-inch brick to a wall of hollow tile. The tiles furnish the air space and also have a "scored" surface to which plaster may be applied directly on the inside. The brick is easily bonded in with the tile to form an exceptionally fine wall. The sketch shows the simplest method of bonding, where a metal bonding clip is embedded in the mortar joints. The tile also comes in special shapes to allow interlocking with the brickwork for a more complete bonding. However, the cost of this brick veneer on hollow tile is considerably more than that of the other walls described.

WHILE costs depend largely on where the building operation is taking place, the variations in expense for different methods of brick construction can be expressed in a general way. The "ideal" method usually would be the cheapest form of brick wall. The four-inch brick veneer on four-inch wood studs would probably run about ten percent higher in cost, while the eight-inch solid wall, furred with one-by-two-inch strips, in most sections of the country, would be about twelve percent higher. The four-inch brick veneer on hollow tile would run as high as thirty percent more. That is, where a certain length and height of wall built in the "ideal" method would cost $1,000, the same area of wall in four-inch veneer on studs would be $1,100, the solid eight-inch wall with furring would be about $1,120, and the veneer on hollow tile would be about $1,300. These figures are based on the assumption that the same quality of brick is used in each case.

It will be seen that Mr. Bentley has used various methods of construction which have effected economies. In no case, however, has he made a substitution which is less sound or where the upkeep would, in time, more than offset the initial saving. In considering the specifications for your house, bear these facts in mind, remembering that the cheapest does not always mean a saving in the long run.

What Do You Want to Know About Building?

MORE articles on building, in which experts will describe modern, economical methods of construction, will appear in coming issues of POPULAR SCIENCE MONTHLY.

Besides the information in these articles, readers can obtain free advice on questions relating to building materials and equipment from the Popular Science Institute Building Service.

Supplementing this service, booklets are being prepared. The first, a twenty-four-page treatise on "Insulation in Building Construction," is now available at twenty-five cents a copy. Address Popular Science Institute Building Service, 250 Fourth Avenue, New York, N. Y.

Putting Lightning to Work

(Continued from page 19)

Does lightning prefer some trees to others—oaks to beech trees, for example? Superstition says it does, and science agrees. Oaks are starchy trees, good conductors of electricity and therefore prize targets for lightning bolts. Beeches are oily and are far less frequently hit. Pine and fir trees are highly susceptible to lightning. Safer shelters are maples, chestnut, alder or ash.

Is it dangerous to be out in a thunderstorm? Statistics show that you are as likely to die from a mad dog's bite or from being hit by a falling brick as by lightning. But, of course, people are killed by lightning—some five hundred a year in this country—and it is well to be careful. If you are caught in a thunderstorm a tree is poor shelter, as it may draw lightning; a cave or the foot of a cliff is a good one. In a home, safety is practically certain. Even if lightning tears off or sets fire to the roof, it seldom can penetrate within. It will run off harmlessly into the earth through the metal pipes of the plumbing system or the wires of the electric supply.

Because of its steel construction, a modern office building is lightning-proof, in spite of the height that would otherwise make it a good target. It even shields the area around it. The Woolworth Building, for example, attracts bolts to it and protects surrounding buildings with a "cone of safety" in which no bolt will strike. The Pulitzer Building, just a few feet outside this "cone," has been struck.

ONE man claims that lightning rods "draw lightning;" another that they prevent it by discharging the electricity that is accumulating in the air. Which is right? The answer is that both are correct. Some flashes probably are prevented by the rods, while others actually do hit them—as many cases show—and are carried safely to earth. The rôle of the rod and wire is apparently less of a conductor than a guide.

One type of lightning bolt, however, does not seem to follow any of the known laws of electricity, and strikes where it will—lightning rod or no lightning rod. Dr. N. E. Dorsey, of the National Research Council, suggests it may be a "dart" of electrons which, unlike those of an electric spark, actually possess momentum and add to their number as they crash earthward—no less, in fact, than the legendary "thunderbolt" of ancient times. Fortunately such bolts are rare, if they exist at all; they remain shrouded in mystery.

THAT lightning may start simultaneously from the earth and the clouds, and join in the middle, is the startling fact disclosed by Prof. C. V. Boys, British physicist, who succeeded in photographing a flash at Tuxedo, N. Y., with a camera of his own invention. He had carried it around the world with him for twenty-six years waiting for a chance to get just that picture. Other photographs have revealed that the apparent zigzag path of lightning is really a corkscrew, or spiral.

So rare that only about a hundred cases of it have been reported in the last century, is "ball lightning." Until recently many experts denied its existence. Mysterious, luminous balls of fire occasionally appear in the air during a thunderstorm, say witnesses. They float leisurely into windows, or down chimneys, and attach themselves to metal objects, according to the stories told. Often they explode with a loud report, leaving what is often described as a "sulphurous" odor. A few accounts tell of these balls alighting upon human beings and burning them. Such stories usually have been discounted by scientific men. Recently, however, the first photograph purporting to show ball lightning, made by an unnamed Swiss photographer, was submitted to the French Academy of Sciences by M. E. Mathias. It showed a forked lightning flash that divided into five parts, each of which terminated in what seemed to be a luminous ball.

Meanwhile a British chemist, E. Kilburn-Scott, suggests a startling but simple theory of ball lightning. He proposes that the electric power of a lightning flash, under favorable circumstances, may fuse the air's constituents into a liquid ball of nitric oxide gas, a colorless poisonous gas, produced by the sudden change of pressure and charged with electricity.

"We know," he points out, "that when lightning strikes through the air it 'fixes' or forms into nitric oxide more than 100 tons of nitrogen each year. In the sudden expansion of air that follows a lightning bolt, conditions are extremely favorable to the production of a large amount of the gas chilled in a concentrated and probably liquid form.

"IF THE gas were 'rolled up into a ball' by the lightning flash it would gravitate slowly to earth, in exactly the way observers have described. Meeting some animal or vegetable material, which it can 'nitrate'—such as a haystack or a tree—we know that such a ball of gas will explode. A violent chemical reaction, similar to that of an explosive, occurs."

Less mysterious than ball lightning, but fully as weird, is an electrical display known as "St. Elmo's fire." An unusually spectacular example occurred recently in Colorado. Ghostly flares played about the summit of Pike's Peak at night. So brilliant were they that they were believed to be signals of a party of stranded mountain climbers. Three aviators flew about the summit looking for human beings, but could find none.

Evidently this was a display of St. Elmo's fire, familiar to sailors in the curious crackling flames that play about mast-tops on a crisp, snowy night. At the former observatory at Ben Nevis, Scotland, such displays were observed as caps of light on lightning rods. Occasionally jets of flame hissed upward from objects atop a tower, reaching a height of six inches at times. An observer, Angus Rankin, reported his hair, hat, and pencil aglow with the strange electric fire, but he experienced no inconvenience save a slight tingling sensation in his hands and head.

Even familiar forked lightning plays strange pranks. It recently wrote its signature upon a Middletown, N. Y., man, who was struck by a bolt. His skin bore a pattern of bright pink lines, the burns of the electric current that had flashed through his body. After a day or two they faded out and disappeared.

Observers strolling along the sand of beaches occasionally come upon rootlike tubes of glassy substance, often projecting an inch or two above the surface. Dug up, they usually are several feet long, with branches and twists. They are the result of a direct stroke of lightning. Tremendous electric currents generate the enormous heat required to fuse wet sand into solid glass, in the form of long hollow tubes. Remarkable specimens of these "fulgurites" are now in museums.

WITH such testimonials to the power of lightning, it seems incredible that any man struck by it should escape death. But electricity at tremendous voltage obeys no ordinary laws. A New York farmer, for instance, took refuge under a tree in a thunderstorm. They found him later, unconscious but alive, stark naked. A bolt of lightning had scattered his clothing in bits about the field. A New England man was knocked down by a stray flash and the soles of his shoes torn off. The best explanation is that if the skin of a lightning victim is moist with perspiration, the instantaneous steam generated by the heat of a flash acts like a miniature explosion and tears off clothes or shoes.

Do Birds Fly by Radio Compass?

(Continued from page 31)

shorten, the winged travelers start preparations for their voyage. There are hectic doings in the woods and in the fields. Every minute of daylight is used by the intercontinental commuters to accumulate the fat that will give them the energy and endurance to fly enormous distances without "refueling."

Then comes the "signal"! The frost line moves down from the North Pole and simultaneously great groups of migratory birds head southward. The first to leave are the Arctic tern and the golden plover, which forsake their darkening subpolar home—the plover for a glowing South American winter resort; the tern to find, after some 11,000 miles of weary winging, a haunt in the Antarctic as cold and bleak as the one it left in the Far North!

THIS Arctic tern, by the way, because it is the champion long-distance nonstop pilot, is the subject of unceasing observation by ornithologists. Mr. Nichols told me of a remarkable instance proving its flying powers. O. L. Austin, Jr., of the Museum of Comparative Zoology at Harvard University, caught a nestling Arctic tern in Turnevik Bay, Labrador, and placed an identifying band upon its leg on July 22, 1927. It was picked up in La Rochelle, France, on October 1, having flown 2,500 miles at the tender age of three months! Even more amazing is the feat of another nestling tern banded in the same bay the following year. It was found fifteen miles southwest of Port Shepstone, Natal, South Africa. It had flown 9,415 miles from its nest before it was four months old!

By the time the frost line reaches Canada, the wild geese, ducks, loons, and cranes take to the air, blackening the skies with their huge mass formations.

Now the "white line" enters the United States, and our friends the robins, bobolinks, and warblers are on the wing, flying by night and hunting food by day. Southward rolls the frost line and finds the martins, chimney swifts, and barn swallows ready for the voyage. Hawks and gulls are the last to depart.

On their long journeys, most birds seldom fly higher than 3,000 feet, but strong flyers have been known to reach an altitude of 29,000 feet. The speed of the smaller perching birds is usually from twenty to thirty-seven miles an hour, that of ducks and geese from forty-two to fifty-nine. Individual cases of speeds far in excess of these figures have been recorded, however. Recently an airplane pilot raced a migrating swallow and found it was making seventy miles an hour!

SPEAKING of swallows, Mr. Nichols suggested that, if it had not been for those little birds, Columbus might never have discovered America!

"Did you know," he asked me, "that Columbus made two entries in his log—one on October 3 and the other on October 7, 1492—showing that he calmed his mutinous sailors by pointing to large southbound swarms of birds as proof that land must be near? Land was sighted on October 12. The birds did not come sufficiently close to the *Santa Maria* to be recognized by Columbus, but the time of their appearance in the neighborhood of San Salvador, now Watling Island, makes it fairly certain that they must have been barn swallows."

"What of the migratory urge itself?" I asked Mr. Nichols. "How is that explained?"

"The explanation most commonly accepted is that the shifting food supply is the basis of the birds' seasonal movements. Another theory ascribes the migration impulse to changes in temperature, the birds passing south to escape the

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Do Birds Fly by Radio Compass?

(*Continued from page 149*)

cold of winter as soon as the cooler air of autumn gives them warning, and, of course, returning again when milder weather sets in up North."

The flights of Canadian geese seem to offer proof of this theory. It has been observed that their yearly arrival at each stop-over point on their journey is timed by the temperature at that point.

"Then we have the theory that birds naturally turn to the region of greatest light and leave that where light is curtailed, following the sun. Still other theories explain the migration urge as the outcome of the power of flight in which the bird rejoices, and as the result of certain glandular activity.

"But all of them," Mr. Nichols continued, "leave many curious phases of bird life unexplained. For instance, why does the Arctic tern, whether it originated in the north or south, make a weary 22,000-mile round trip to spend its life in the perpetual daylight of the subpolar regions? And why does the yellow wagtail of Alaska fly to the Orient and spend the winter months along the coast of China? Why do six different species of birds breed north of the Arctic Circle and winter in Patagonia at the southern tip of South America?"

"AND your own theory?" I asked Mr. Nichols.

"I believe," he replied, "that the struggle for existence has much to do with migratory bird habits. Migration begins only when a species has increased to a point where it is crowding its range. At first birds wandered indiscriminately. Some succeeded in returning occasionally to the original home, perhaps from only a short distance. With this homing habit once established, the distance between winter and summer homes may have become greater and greater.

"A recent example illustrates what I mean. Since the irrigated lands in the West have become settled, the bobolinks have extended their range a thousand miles beyond the Mississippi Valley regions that once marked the westward limits of their range. Yet, each fall, instead of heading directly south, these birds fly a thousand miles eastward to start on their migration from the old spot.

"This theory does not, of course, explain the principles that have controlled the migration habit. The truth is that the entire matter of migration is so complex that no one single factor can be given as the absolute cause."

MR. NICHOLS told me some of the bizarre superstitions concerning bird migration in olden days.

"Do you know," he said, "that in early times the disappearance of certain birds was attributed to hibernation? They were supposed to pass suddenly into a torpid state and so spend the winter hidden in caves and hollow trees or embedded in the mud at the bottom of marshes, ponds, and streams! To this day, peasants in southern Europe still think that the smaller birds congregate on the shores of the Mediterranean Sea, where they wait for a suitable opportunity to 'book passage' on the commodious wings of storks and cranes!

"In a treatise published in London in 1703, the author expressed his belief that migratory birds, on leaving England, flew straight to the moon, where they spent the winter season. He had even timed the lunar trip; it took exactly sixty days!

"Even the great Swedish naturalist Linnaeus, the founder of modern botany, actually thought that swallows plunged headlong beneath the waters of a neighboring pond to spend the winter hibernating in the mud at the bottom!"

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Do Birds Fly by Radio Compass?

(Continued from page 150)

It is still a mystery where the chimney swifts of the United States spend the winter. Great flocks of them fly south, their number increasing as they go. They reach the Gulf of Mexico and disappear! A plausible theory is that they migrate to South America, as do other birds, but, because of their dusky hue and swift, darting flight, are not noticed among the swarming armies of brighter colored birds.

A great aid in learning the habits of migratory birds has been that of banding them. This consists of trapping a migratory bird, clamping a band, which is serially numbered for identification, upon its left leg, and then releasing it again. The United States Biological Survey keeps records of banded birds and reports of their movements. Since 1920, the Survey has established some 2,500 banding stations, operated by volunteer students of bird lore under permits of the Department of Agriculture. So far, more than 450,000 birds of 231 different species have been banded.

THE trapping methods used at present, Mr. Nichols told me, were developed by S. Prentiss Baldwin, of Cleveland, Ohio, who is president of the Inland Bird-Banding Association. The wire cage trap he invented does not injure the bird and is most valuable because it permits the making of consecutive records of the same specimen.

Mr. Baldwin started bird-banding a few years ago as a hobby; today he is a recognized authority on ornithology and his two big stations near Cleveland are veritable bird detective agencies. Among other strange facts Mr. Baldwin has established that birds have a family life in many respects similar to that of men. He found that the same pair of birds usually live together for a number of years. The older birds, as a rule, are satisfied with the first place in which they set up housekeeping. But often the ambitious youngsters decide that the neighborhood is no longer good enough for them and, shortly after they have learned to fly, move to another section. Occasionally, Mr. Baldwin has observed, birds divorce each other and find new mates.

But despite the great volume of knowledge gained in recent years, most of the puzzles of bird migration remain unsolved. Some day, no doubt, science will penetrate the veil that now shrouds the magic of these long aerial treks. Then we shall really know whether birds of passage are guided by miniature cerebral "radio-compasses" or whether they are, perhaps, the little masters of some strange astronomical art that enables them to set their course according to the sun by day and to read the stars by night.

"Average Inventor" Begins His Work at 25

A PROFESSOR at the University of Michigan has discovered the "average inventor," and tells us how long he works on an idea, at what age he applies for his first patent and how much money he makes. By sending out questionnaires to 137 typical inventors, picked at random from Patent Office records, and taking the average of their replies, he arrived at his conclusions.

This "average inventor," the professor says, is bitten by the "bug" at the age of 25. He is 31 before he applies for his first patent. He keeps on inventing things for sixteen years. He spends on the average, one year, eight months and three days on each invention. In return for his work, he averages $37.25 a week. But the thrill of creation and the solving of problems that have baffled others, give the inventor the real reward for his labors.

Eyes That Never Sleep

(*Continued from page 62*)

broken, and a spring or other lever released.

Before it will operate machinery, however, the feeble electric current of the eye has to be amplified millions of times. Just as a man, by pressing a button, can set off a blast that will move a mountain, so the eye's infinitesimal power will operate sensitive electric relays that magnify it a millionfold.

One of the most remarkable of these relays is the "Knowles grid-glow tube," a vacuum tube filled with neon gas that burns with a pinkish glow. So sensitive is the tube, it is said, that "a fortieth of a fly power" can operate it.

A few months ago an automobile salesroom in New York City displayed a unique advertisement. "Place your finger on the red spot on the show window," a sign advised. At the slightest touch, as directed, a driverless car in the showroom rolled up an inclined runway as if some unseen hand were moving it. Crowds that gathered to watch the demonstration blocked traffic.

THE secret of the trick lay in an inconspicuous piece of tinfoil pasted on the inside of the window, from which led a wire to a Knowles grid-glow tube. Merely placing a finger on the *outside* of the window opposite the foil was sufficient to disturb the electric charge of the tube and to start it working. Its power, amplified ten million times, ran an electric motor in the car.

Even professional magicians are fooled by the scientific wonder. When these masters of sleight-of-hand met at a recent convention, a guest exhibited a little magic of his own. His equipment was simple; two ordinary looking black boxes, and a pack of cards.

"Choose a card," he invited, "and remember which one it was." By the old trick of using a "forcing" deck he made the nearest magician select the card he wanted—the three of clubs. "Now," he continued, "put your hand over this black box and see what happens." The magician did as directed. His eyes opened wide in astonishment. From the other box slowly rose a huge card upon which were engraved three clubs.

The guest was a member of the physics department of Columbia University. Within the first black box was a grid-glow tube that, at the approach of a hand, had set in motion the electric machinery that produced the phantom card. "You magicians might read up on your science and learn a few new tricks," was the Columbia man's comment.

USEFUL magic, too, is that of the grid-glow tube. It will safeguard an oil-burner by making it impossible to turn on the oil unless the pilot is lit—thus avoiding a possible explosion. In most oil burners with gas pilot lights the safety lock is a thermostatic device, operated by the flame's heat; but such a device requires several seconds to operate. The electric device clicks off the oil valve instantly if the pilot flame goes out. Its source of power is the tiny current that the hot gases of a flame will conduct to the metal casing from a wire terminal in the middle of the flame.

One manufacturer recently installed such a device on an annealing oven in his Newark, N. J., shop. It worked splendidly, except that whenever anyone approached within two or three feet of the furnace the "robot" turned off the oil! A few changes in the electrical connections corrected this ultra-sensitiveness.

An inquisitive hand approaching the tube, or any tin foil strip connected to it, is sufficient to set off an alarm—a fact that recommends it as a burglar alarm in jewelers' shops, for instance, where a strip of foil beneath a showcase would set off a siren if any night intruder placed a hand on the case.

A definite program for getting ahead financially will be found on page four of this issue.

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A Bigger Ditch Than the Panama

(*Continued from page 35*)

sixteen-mile-wide barrier of hills and rugged peaks bars the lake from the Pacific. Through this wall engineers would have to cut a passage.

Vicious sharks and swordfish infesting Lake Nicaragua will menace the masters of dredges and dynamite hewing the canal. The present proposal is to run a forty-four-mile canal eastward from the Atlantic mouth of the San Juan River, separated from it at points by dikes. Four locks would raise vessels making the ascent. A dam at Conchuda would convert the upper fifty miles of the river into an arm of Lake Nicaragua.

Across the shallow lake, which has only a few spots as deep as 200 feet, a channel would be dredged and through it ships would steam to the western shore. There the canal route would pierce the Continental Divide and drop through four locks to the level of the Pacific Ocean.

ALTERNATIVE routes have been suggested. With its option to build the canal, the U. S. Government acquired the right to erect a naval station at the Gulf of Fonseca, on the Pacific Ocean, where one proposed canal route might terminate after traversing Lake Nicaragua and its connecting lake, Managua, seen just above it in the accompanying map. Two other routes would cut a waterway from Lake Managua directly westward to the sea.

For twenty-five years a heated controversy has raged between the advocates of the Nicaragua canal and its critics, and always the discussion has centered about volcanoes. On an island in Lake Nicaragua not ten miles from the proposed canal route stands the ever-smoking cone of Ometepe, which erupted four years ago. Ten miles south of the lake's lower end, just across the border in Costa Rica, is the grumbling volcano, Orosi. Towering over the northern end of Lake Managua, Mt. Momotombo threatens the northern route to the Gulf of Fonseca. Should any one of these volcanoes suddenly become violently active, critics point out, a billion-dollar canal might be put out of business in a few minutes.

THE Nicaragua Canal would take from eighteen to thirty-six hours to traverse, as compared with six to eight at Panama. But it would clip a day's sailing time from New York to San Francisco, and about two days from New Orleans to the west coast. Two harbors would need to be created for the Nicaragua project, and a 120-mile railroad built. At Panama two fair harbors already existed, and a railroad was taken over. The entire Panama route is about forty-seven miles long; the Nicaragua route, about 183 miles.

There are the facts, and it is up to Uncle Sam to decide whether he is going to tackle the billion-dollar job. Engineers agree that if work started tomorrow, the canal would be ready for ships only by 1940. By that time, observers ask, will even an enlarged Panama Canal suffice for increasing commerce?

Research Two Miles High

RESEARCH that is bound to advance aviation will be conducted in a new international laboratory being built on Sprinx Peak, an 11,500-foot-high spur of the Jungfrau, one of the tallest mountains in the Swiss Alps. Here scientists will study the effects of rarefied air and of the sun's rays upon human beings, as well as animals and plants, in high altitudes.

Other research will be conducted at the unique institution, which is being established under the auspices of the International Education Board of the Rockefeller Foundation, the German Kaiser Wilhelm Institute, and other scientific organizations.

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Stranded—Seven Miles Up!

(Continued from page 23)

"Right then I gave up any idea of getting back to Dayton. I headed for the nearest field, near Sexton, Ind., and landed."

According to his companion, Captain Stevens, the landing itself, particularly in an altitude ship that "flew like a barn door," was a remarkable feat of air piloting. With a stalled motor, Captain Streett cruised squarely over the field, gaging its size, then made a skillful half turn on a wing tip and landed with fully two thirds of the field to spare. There the aviators took on a fresh gasoline supply. The trouble with the motor control, caused by the shrinking of a bolt in the extreme cold, remedied itself in the warmer atmosphere, and they returned to Dayton, none the worse for their harrowing experience.

The photographs, when developed, proved a striking vindication of Captain Stevens' theory. Measuring them, it was possible to estimate the plane's height at the time with an accuracy of one part in a thousand; and they may eventually replace the barograph method.

A BATTLE Captain Streett fought with flames on a previous flight stands out as another drama of sheer courage. He told me the story in his self-deprecating way.

"One morning, at daybreak, I took off from Jasper, Canada, with my mechanic, Sergt. Henriques, and headed across the Great Divide for Prince George. We hadn't been on our way long before something went wrong with the oil line, and a geyser of oil spurted over the engine. Plumes of smoke shot out, and in a second it was a mass of flames. I grabbed a fire extinguisher, and told Henriques to take the controls. I started climbing out on the wing to get to a place where I could play a stream on the motor. But the wing itself was slippery with oil, and I couldn't make it. The question was, what to do next?"

A forced landing was out of the question in that rugged country. Captain Streett and his mechanic refused to take to their parachutes and let the machine crash. Instead, Streett turned it around and headed back for Jasper, fifteen miles away!

"We didn't waste any time getting back," Captain Streett smiled.

What a race with fire that must have been! But when the plane swooped to a landing, the oil had burned away, happily without setting the tanks afire. The only damage was a charred set of spark plug cables.

Other adventures? I asked Captain Streett if he had ever cracked up in a plane.

"No," he said. "Wait a minute—yes, I have, too, once. Twice, in fact. Once in France, during the war, I brought a plane down on a wet field and it nosed over with its tail straight up in the air. Then I cracked up again one time at Wilmington, Delaware—I'd forgotten it."

IF A great plane, coming to earth with you in it, had turned completely over, pinning you beneath, would you forget the experience so easily?

"Oh, well," said Captain Streett, "I crawled out without a scratch, so what of it?"

There is one person, at least, who does not take his doings so lightly—Mrs. Streett. "How about the time you tore off a wing, Billy?" She asked.

"Just the fabric off one wing, Mary," Captain Streett corrected. "Stunting, with a biplane, and the cover of one wing ripped off. That was all."

All he would admit, at least. Not a word about the struggle with the controls to bring the crippled plane safely to earth.

As a matter of fact, Captain Streett claims he has been more scared on the ground than in the air. "My pet abomination," he said, "is the speed maniac who (Continued on page 157)

Stranded—Seven Miles Up!

(Continued from page 156)

drives me from the field in an automobile. People seem to think that because aviators travel fast, they like speed. That may be all right in the air—but I won't ride more than once with the wild driver who tries to show off his car's speed with me in it."

Two things of interest I learned about the airman's code. "In the first place," Captain Streett said, "if a pilot worried about what might happen to him in the air, he wouldn't fly. There are too many unnerving things that might happen but generally don't. So a pilot doesn't worry. If a pilot doesn't feel competent to cope with any emergency, he has no business in a plane."

And the second is that memory of an unnerving experience is left behind almost at the moment a pilot's plane touches its landing wheels to earth. "You may miss the wings of another plane by inches, flying in formation," said Streett, "and say to the fellows when you come down, 'Well boys, I just picked up two or three new gray hairs.' But that's the end of it. Of course, the pilot who says he's never been scared is lying. I've been scared so many times myself that I've lost count."

CAPTAIN STREETT never expected to be a flyer. At eighteen or nineteen he was studying medicine at Tulane University—and building model airplanes as a spare-time hobby. Aviation at that time was less of a profession than a dare-devil stunt. It appealed to young blood as a great adventure, and young Streett yearned to fly. His father frowned upon the idea.

Two things happened, in quick succession, that had a profound effect on Captain Streett's career. His father died, in 1913. Then came the World War.

"We young fellows saw other Americans going to France to join the Lafayette Escadrille, a branch of the French foreign legion," he said. "Bill Thaw was over there, Raoul Lufberry had gone from Connecticut, Norman Prince from Boston, and Kiffin Rockwell from Connecticut. That settled it; I had to be a flyer, too. I quit the job I had then, as a purser with the Merchant Marine, and joined the Aviation Section of the U. S. Army Signal Corps—the tiny nucleus that was later to become the Air Corps.

"My mother didn't object. She seemed to think I'd have to work out my own life for myself, whatever way I chose—a good sport, don't you think? Naturally, I didn't have much trouble thinking up good reasons why I should be an aviator.

"TWO months of ground training at Newport News, and I made my first solo flight. October, 1917, found me on my way to France. I wound up at Issoudun, a great aviation training school south of the Loire Valley, where I remained as flying instructor until the signing of the Armistice. After that, I was with the Army of Occupation, returning to this country in 1919. The following year, the Alaskan expedition took me north."

It is hard, in 1929, to conceive what it meant to lead the first aerial expedition from New York to Nome, Alaska. Landing fields, in those days, were often transformed cornfields. Only as far as Erie, Pa., one of the four De Havillands that blazed the trail to the Yukon became stuck in mud so thick that even the horses attempting to pull it out became bogged! Yet all four planes arrived in Nome, Alaska, in fifty-three and a half flying hours from New York, the elapsed time being forty days. And the return journey to New York was completed in a total flying time of only 112 flying hours. For this trip Captain Streett received the Distinguished Flying Cross. For some years after, he was in the office of the Chief of Air Corps at Washington, D. C.

In 1925 Streett entered (Continued on page 158)

Stranded—Seven Miles Up!

(Continued from page 157)

the Air Service Tactical School as a student, and went from there to Selfridge Field, Mt. Clemens, Mich., to join the First Pursuit Group. He was back in the air again. Thence he went to Wright Field. Here, while he has been in charge of flying tests, Captain Streett told me, many exciting dramas of the air have been written. Just the other day, for instance, Lieut. Julian B. Haddon fell four miles unconscious in a plane he was testing at high altitude. He recovered his senses at 10,000 feet to find the plane afire, and jumped with his parachute just in time to save his life.

"Speaking of fire thrillers," Captain Streett said, "let me tell you of one of the queerest accidents of all, that Lieut. J. T. Hutchinson had not long ago. He took up a new bomber, of an experimental type, to see how it would behave in the air. It didn't take him long to find out. In the middle of a climb for altitude, smoke shot out of the engine. Hutchinson peered over the dashboard, saw a seething mass of flames, and decided the cockpit was no place for him. A second later he was swinging to earth at the end of his parachute.

"THEN, looking back at the plane he had left, he saw a sight that sent cold shivers up and down his spine. The pilotless plane, now in flames, had swung about nose down and was headed straight for him!

"That was the start of a hair-raising race to earth. Helpless at the end of his parachute, Hutchinson alternately swore and prayed that the fiery torch wouldn't hit him, crumpling or igniting his flimsy 'chute of silk. Around and around him spiraled the burning plane, at times so close that he could feel the heat on his perspiring brow. The race ended safely, as luck would have it. Hutchinson hit Wright Field with a jolt, and the plane crashed only a few yards away, a charred ruin."

Spending more than half the time in the air, Captain Streett has aided in important aviation research. Besides the experiment in taking high-altitude photographs, he helped Lieut. A. C. Foulk, in charge of the Air Corps' Matériel Division's Parachute Unit, to find out how strong a parachute needs to be made. Hitherto no one had known whether it was safe for an airman to fall thousands of feet before opening his 'chute, instead of counting a few seconds and pulling the rip cord that unfurled it.

How fast does a man fall? That question was answered by dropping dummies from a plane piloted by Captain Streett. They were the size and shape of a man, and carried flares by which their fall could be traced at night. A camera set up on the ground, with a shutter that winked at one-second intervals, took pictures of the dummy's path to check the distance it fell in each interval. The results were surprising.

AFTER a man has fallen for about 1,600 feet, the tests showed, he doesn't go any faster! In other words, if one man were to leap from the top of the Eiffel Tower, and another to jump from a plane four miles high—equal to a world's record parachute jump of 24,000 feet made by Captain Stevens—the two men would be falling nearly at the same speed when they reached the ground. Air resistance produces this remarkable slowing, and even without a parachute the fastest a man can fall is 130 miles an hour. It is a simple matter to design parachutes for this strain, now that the exact figure is known. And a jumper may delay opening his 'chute as long as he pleases without fear of ripping it.

So Captain Streett, in the course of his varied career, has helped revise the law of gravity as far as its practical application is concerned. Just another incident in the life of an aviator whose career has been a series of thrillers and "queer ones."

War Gas Fights Peace-Time Foes

(Continued from page 24)

midst of preparing a meal, unaware that a stray wind has blown out the flame of a gas burner. This was the menace the Chemical Warfare Service set out to end.

"Sneeze gas," a nose-irritating compound of war days, came to mind. In small quantities it is comparatively harmless, but it provokes violent sneezing. Following the Chemical Service's tests, artificial gas companies are beginning to add a small quantity of the "sneeze gas" to every thousand feet of artificial fuel gas. "Now, if a burner is left on," General Fries explained, "the new gas will cause violent sneezing and so give warning. It is doubly effective, because it will awaken sleeping persons as well. When burning, the sneeze gas gives off no odor."

A new "skunk gas" developed by the Chemical Warfare Service also is being used extensively by gas companies as a warning against leaks. Entirely harmless, its odor, except when burning, is exactly what its name implies. It would discourage any but the most desperate suicide from ending his life by gas.

WHEN western farmers vainly fought a one-sided battle against jack rabbits not long ago, another new use for poison gas came into existence. The farmers, watching their crops ravaged by the rabbit invasion, appealed to the Government for aid. The chemical experts had on hand a small quantity of mustard gas, a lung-searing terror of the World War; and, under their direction, the farmers gingerly released it over rabbit trails, where it condensed in droplets upon the ground like dew. In traveling over their accustomed trails the feet of the rabbits picked up the mustard gas. The rabbits licked their feet, according to their habit, and died. That was the end of the rabbit plague.

When the war ended, huge supplies of "hydrocyanic" gas became available for peace-time use. The same qualities that had made it a brutal killer in French shells—paralyzing the nervous system and causing a horrible death—made it a splendid fumigating gas for a ship's hold, in all respects but one. It effectively killed rats and their parasitic fleas, carriers of bubonic plague and typhus fever; but—

One day a ship from Australia entered San Francisco harbor, and a Public Health Service inspector climbed aboard to make sure that regulations requiring fumigation had been complied with. They had. Some hours later the inspector was found dead in the hold. Hydrocyanic gas, which gives no warning of its presence, had been used, and traces still remained.

WHEN several deaths from this cause were reported, General Fries explained, the Chemical Warfare Service tried mixing with the deadly "hydrocyanic" one of the varieties of tear gas called "cyanogen chloride." After extensive experiments in Army posts and Army bakeries, the mixture was turned over to the Public Health Service for use on ships. It gives timely warning of its presence by the life-saving tears it induces.

War poisons are being pressed into service also against plant pests. There is the story, for instance, of Joe Johnson, a war veteran, who found occasion to be grateful for the very gas he had cursed overseas.

With congested lungs to cure, and a compensation from the Veterans' Bureau to aid him, Johnson went to Hawaii and embarked on a career as a pineapple grower. It was hard sledding. His capital was small, and crops were disappointing. Other planters, he found, were having similar trouble. Government chemists, called in, found out why. Tiny parasites—"nematodes," the chemists called them—were growing on the

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War Gas Fights Peace-Time Foes

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pineapple roots and sapping the plants' vitality.

Soon a number of containers arrived from Washington, filled with "chloropicrin"—a quick-evaporating form of tear gas, the same stuff that had made the ex-soldier's eyes smart on the western front. The planters were told to sprinkle a few drops around each pineapple plant. Before long the root growths doubled. The parasites were killed, and a healthy crop of pineapples followed.

Similarly, General Fries told me, chemicals are being developed to end the ravages of boll weevils that ruin cotton plantations, and pests that infest fruit orchards. They are most effectively sprayed over large areas from airplanes, with sprayers of the type developed during the war to lay down smoke screens.

"Poison gas dope" to protect the pilings of docks from marine borers is another innovation. It is a compound formed from creosote and a war poison gas known as "diphenylamine-chlorarsine"— pronounce it if you can!— together with several other chemicals. Test pilings treated with it have withstood borers for three years, at this writing. Now the Service has also concocted a "poison paint" which keeps a ship's hull free of barnacles.

ONE of the most striking possibilities of the near future that General Fries suggested to me was the idea of hurling poison gas from the air to extinguish fires.

Last summer General Fries, touring the West, witnessed first hand the destructive effects of forest fires and the seeming inability of present equipment to cope with them. He recalled that at the close of the war the Chemical Warfare Service had perfected a new gas thrower to be attached to airplanes, and to spray mustard gas in large drops upon enemy troops. The Armistice prevented its expected use all along the western front, and left the service with a number of useless airplane sprayers on its hands.

Now, General Fries said, the service is considering loading them with a fire-extinguishing liquid such as carbon-tetrachloride, familiar also as a household solvent, which, when it evaporates, creates a flame-proof blanket of gas and smothers the fire.

"If the forest service would equip a dozen airplanes with the sprayers, they could keep fires down to a minimum," he said. "At the first report of a conflagration, the 'air fire engines,' which might be a hundred or two hundred miles away, could take off for the scene. Flying at a low but safe altitude, they would spray the flames with the extinguisher. The large drops, which will not break up in the air, would extinguish the fire completely in a few hours. Otherwise, as at present, it might burn for days. Think of the trouble, the labor, and the miles of valuable timberland which could be saved."

A Strange "Death Valley"

THE secret of a weird "Death Valley" on the island of Java has just been uncovered by chemists of the Volcanological Survey of the Dutch East Indies. The valley, a natural bowl on the slopes of the volcano Tangkoban Praho, is paved with the bones of animals and lizards that entered and never returned.

Inconspicuous vents in the sides of the valley were found to be pouring forth a deadly barrage of poison gas, hydrogen sulphide. This is the evil-smelling gas given off by bad eggs. In small quantities in the atmosphere, it is not dangerous, but in the Java "Death Valley" the air contained as much as ten percent of the fumes. This is sufficient, in a few seconds, to kill anything breathing the air.

Back of the Month's News

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winds over the dry land of Southern Russia, 2,500 miles away.

Without dust in the air, we would have no beautiful colored sunsets, and no rain. Up to a certain point, it is beneficial. The problem of determining how much dust and smoke the air can contain without injuring the health of those below, is one that science is seeking to solve.

What Has Become of the Pioneer Flyers?

IN WASHINGTON the other day the Secretary of War gave America's Distinguished Flying Cross to Orville Wright and, posthumously, to his brother Wilbur for their invention and development of the airplane. The flying machine is twenty-five years old. Many other of the pioneers of flight are still alive. Where are they, and what are they doing?

The first man to make a public flight in the United States was F. W. Baldwin, who took the Aerial Experiment Association biplane, *Red Wing*, into the air in 1908. He is in Canada working on a new type of motor boat. Alberto Santós-Dumont, who hopped 600 feet in a sort of motored box kite near Paris in 1906, the first flight in Europe, divides his time between France and his large coffee plantation in Brazil. A. V. Roe, first Englishman to fly a British plane in England, is head of a company making light planes. As early as 1907, Robert Esnault-Pelterie, the French scientist, was flying in his curious "R.E.P." monoplane. He is now trying to solve the problem of interplanetary transportation.

Louis Blériot, whose crossing of the English Channel in 1909 was one of the milestones of flight history, makes planes in France, as does Louis Paulham, the spectacular Farman pilot who won $100,000 in prizes with his biplane in 1910. The year before, he had been working for ten dollars a week as a mechanic.

The American pioneer, Glenn Curtiss, is devoting his time to real estate development in the South. W. Starling Burgess, who in 1908 was hopping his original biplane over a field on Plum Island, off the coast of Massachusetts, is head of a firm of naval architects in New York City.

Four of the pilots who won the Gordon Bennett Cup Race, the prewar speed classic, are still alive. All except Curtiss, the first winner, are in the automobile business. Claude Grahame-White, who captured the cup in 1910, sells automobiles in England. Charles T. Weymann, an American who never lived in America (he was born in Haiti and resided in France), won the cup in 1912. His fabric automobile body, based upon an idea obtained in flying, is made in France and England. Maurice Prevost, who took the cup to France in 1913, is manager of a garage in Reims, France.

Henri Farman, one of the earliest of the brood of European birdmen, is making planes in France with his brother, Maurice, also a pioneer. Gabriel Voison, designer of Farman's first Voison biplane, is general manager of the Voison automobile works, near Paris.

Many of the flyers who handled the clattering, chain-driven Wright biplanes in early days are still alive. Griffith Brewer, English friend of the Wrights and pilot of the first Wright machine imported into Great Britain, is a patent attorney in London. Harry N. Atwood is head of a manufacturing concern in Monson, Mass. Howard Reinehart, once chief pilot for the Wrights, is running an airport near Dayton, Ohio. Katherine Stinson, one of the few women who mastered the slow-moving Wright machine, and who taught her brother, the famous "Eddie" Stinson, to fly, designs houses in Santa Fe, New Mexico. Harry N. Jones runs a radio and electrical

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store in Portland, Maine. Frank T. Coffyn, head pilot of the Wright School in its palmy 1911 days, sells real estate in Hollywood, Calif., as do two other early airmen, Earle T. Ovington, 1911 American Bleriot flyer, and Charles F. Willard, one of the original Curtiss exhibition pilots.

Two others who "barnstormed" with the Curtiss flyers in the early days are Charles Witmer and Augustus Post. Witmer raises chickens in California and Post is writing and lecturing on aviation.

The Fiddle-Maker's Secret

REPORTS from Rome telling of the discovery of papers written by Antonio Stradivari, who died in 1728, set the world of musicians on edge in anticipation of the revelation of the secret of Stradivari's varnish. For the violins made by Stradivari and his sons, to whom he imparted the secrets of his art, are the finest ever made. To possess one is the ambition of every fiddler; to own one requires the investment of from $25,000 to $100,000, so highly are these instruments prized for their musical tone alone.

If the secret of the varnish which Stradivari used could be discovered, violin-makers believe, new instruments equaling these old masterpieces in tone could be made today. Their great age alone does not make these instruments so precious. Nicolas Amati, Stradivari's predecessor and teacher, made fine violins, some of which are still in use, but the best of them, though older, do not equal the "strads." Violins made by Guarnerius and other contemporaries of Stradivari have been equaled by those of modern makers. The Strads stand alone.

According to Milan authorities, the formula for the Stradivari varnish was actually found among the old papers, and has been tried by an instrument maker of that city. Experts are skeptical, however, awaiting an actual demonstration. Every conceivable test has been applied to the varnish of genuine Strads, in the effort to analyze it and reproduce it, but without success. That the method of applying it has as much to do with its tone-producing quality as its composition is probable. Stradivari is known to have apologized for the delay in delivering a violin by saying that the time required for his varnish to dry made it impossible for the job to be finished sooner.

All varnish is made from resin of one sort or another, dissolved in oil, alcohol, or turpentine. Fossil resins such as amber, which is mined along the shores of the Baltic, where it was deposited by great forests of trees which grew before the last Ice Age, 1,250,000 years ago, and copal, similarly mined in Zanzibar, make the highest grade of varnish. Kauri gum from New Zealand is valuable for high-grade varnish, while most of the commercial varnishes are made from the resin of the southern pine.

Probably Stradivari used either amber or copal, mixed with some pigment to produce the orange-red color of his violins. It is known that each coat of varnish applied to any of his violins was rubbed with the bare hands of men and women day after day while it was hardening. An earlier violin-maker of Crémona in a letter to Galileo said that his instruments could not be brought to perfection without the strong heat of the sun, so it may be imagined that each Strad had its long series of sun baths before it was delivered.

No violin made since 1740, when Stradivari's sons retired from business and locked up their secrets, has been able to produce the tones which a genuine Strad sings. Nor will any until the secret of the old maestro's varnish is rediscovered.

Tools to Keep Your Auto in Repair

By RAY F. KUNS

Principal, Automotive Trades School
Cincinnati, Ohio

MANY home workshop enthusiasts take pride in keeping their cars in repair. Others attempt to do it with indifferent success. Often the difference lies in the tools rather than the men. Repair and servicing operations require the use of good hand tools, carefully selected.

There are many places on every automobile where special wrenches and appliances make the hard task easy. A variety of wrenches is needed. A 12- or 14-in. pipe wrench in the kit serves many uses about the automobile as well as for plumbing repairs. Another general purpose tool is the monkey wrench. A 14-in. monkey wrench will handle much of the rough work on large nuts about the car. The 8- and 10-in. sizes of adjustable end wrenches are especially desirable for carrying in the tool kit of the car. For tappet adjustments, a set of special end wrenches will make the work easier. Spark plugs also may be handled most satisfactorily with a special wrench.

The end wrenches preferred by the author are the following or their equivalent: Nos. 21, 23, 25, 27, and 29 to fit U.S.S. nuts, and Nos. 721, 723, 725, 727, and 729 in the S.A.E. nut sizes.

Special wrenches of odd shapes for awkward places are available in a large variety; be sure to get the ones designed for your own car. The T-handled socket wrench is excellent for speedily removing crank case pans, and running nuts on and off when adjusting rod or main bearings. It is always safe to purchase speed wrenches in the $\frac{5}{16}$- and $\frac{3}{8}$-in. S.A.E. sizes.

A breast or electric drill, a hand drill, and a bit brace are of use in auto repair work as well as in making furniture or household repairs. The drill bits for the breast and hand drill should be in an assortment of sizes up to $\frac{3}{8}$ in.

THE bearing scraper is a necessity for bearing work and a valve spring lifting tool should be selected for your own particular car.

Measuring and marking tools for automobile work include a try-square, a steel rule, and calipers. In addition there should be a thickness gage for testing the clearness of valve stems, pistons, and similar parts.

Ball peen hammers in the 1- and 2-lb. sizes are desirable. Chisels, punches, and screw drivers of varying sizes are included in the well-stocked kit.

The soldering iron is often used for electrical repairs, but it also is called into service for repair work on the gas tank, fuel tubes, and radiator. In connection with its use a gasoline torch is handy; it serves to heat the iron and, when necessary, the work. Tin snips, hack saw, files, and similar tools find a multitude of uses, both about the automobile and in other home workshop jobs.

When Valves Get Out of Step

(Continued from page 84)

revolution. The rest of the time it spends pushing out the burned gas, pulling in a new charge, and ramming it into a small space so it'll explode with plenty of pep when the spark occurs."

"Then," Van Tine observed, "if that's the case I can see why the valves have to open and close at the right time. If they didn't, the piston couldn't do those stunts."

"Exactly," said Gus. "When the piston starts down on the intake stroke, the intake valve must be open to let the gas rush in, and so on. When you stepped on the starter last night I could hear a funny hissing noise from the carburetor that told me the intake valve didn't open until the piston was quite a way down in the cylinder and stayed open long after the piston started up again, so that what little charge got in was pushed right out again through the carburetor instead of being compressed."

"Now that you mention it," admitted Van Tine, "I noticed that funny noise, only I couldn't make out what it was, so I didn't pay any attention to it."

"Next time you'll know better," said Gus. "When a motor makes queer noises it's always trying to tell you something is wrong. The chances are it isn't important, but it always pays to investigate anyhow.

"TIMING a motor," Gus continued, "would be a tough job if you had to time the valves one at a time. But because all the valves are worked by the cams mounted on a single shaft, you don't have to do it that way. If you get either the exhaust or the intake valve for any cylinder timed right, then all the rest of the valves in the engine are bound to be in time."

"Sounds logical," Van Tine agreed. "Now how do you find out how to time one of the valves?"

"Any good auto mechanic can time the valves so the engine will run pretty well, but you can't do an absolutely accurate job unless you know the auto maker's specifications for timing or unless the flywheel is marked with timing lines."

"Aren't all gasoline motors timed alike?" Van Tine asked. "What's the flywheel got to do with it?"

"They're not alike," replied Gus, "because the valve timing depends on a lot of things, such as the diameter of the valves, the shape of the cams on the cam shaft, and how high they lift the valves. In some motors, for instance, the exhaust valve closes just as the piston reaches the top. In others the exhaust valve doesn't close till the crank shaft has gone past top position as much as thirty-two degrees. This happens to be one of the top dead center cars and there's a line cut on the flywheel which tells, when you get it in line with the pointer, that the piston is on top dead center. So all we have to do to time this car is to turn the crank till the marks line with each other, find out which piston happens to be at the top, and set the cam shaft so the exhaust valve for that cylinder is just closed, and the job is done."

"HOW do you find out if the piston is at top center?"

"Easiest way I know, "replied Gus, "is to take out a spark plug and shove a piece of wire into the cylinder so you can feel when the piston gets to the top."

"If I'd done that and checked up the position of the valves when I had one of those spark plugs out last night, I could have located the trouble right away, couldn't I?" suggested Van Tine.

"Put that down in your notebook so you won't forget it!" Gus smiled.

Your Headlights and Bumpers are CHROMIUM PLATED

What is Chromium Plating?

CHROMIUM plating is a process much like nickel plating. It consists of depositing on an article a covering of chromium plate. The plater is responsible for the strength of his solution so far as chemical formula and load is concerned. The process is essentially electro-chemical. Three factors are closely related in the successful operation of chromium plating operations—1. The composition of the Chromium Bath—2. The current density or the proper amperage for the load and—3. The proper automatic control of the temperature of the solution. Variance of either current applied or temperature greatly affects the finished product.

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Here Are Correct Answers to Questions on Page 45

1. There is no difference whatever between so-called "static" electricity and the other forms of electrical energy. All forms of electrical energy are manifestations caused by a disturbance in the make-up of matter which, according to the latest theories, is composed of positive protons and negative electrons.

2. If a current of electricity amounting to one half an ampere is forced through the human body, the result will be death. The voltage required to force this amount of current through the body depends on the resistance the electric current encounters in getting into and out of the body. That is why the shock you get when you touch, with the end of your finger, the "live" contact in a 110-volt light socket is not fatal. You can get a severe shock from a 45-volt B-battery if your hands are wet and you grasp large metal electrodes connected to the battery terminals. People have been killed by 110-volt light current. If, for instance, you are standing in a bathtub full of water and you turn the light switch you may be killed if the switch is defective.

3. Air in its normal state is a nonconductor of electricity, but if you apply enough voltage or pressure, the air becomes ionized and in that state it is a relatively good conductor.

4. Ordinary electric light bulbs pop when they are broken because practically all the air has been pumped out of the bulb and when the glass no longer supports the outside pressure, the air rushes into the vacant space so violently as to create the noise. The larger sizes of bulbs of the nitrogen filled type do not make much of a pop because the gas pressure inside is not much less than outside.

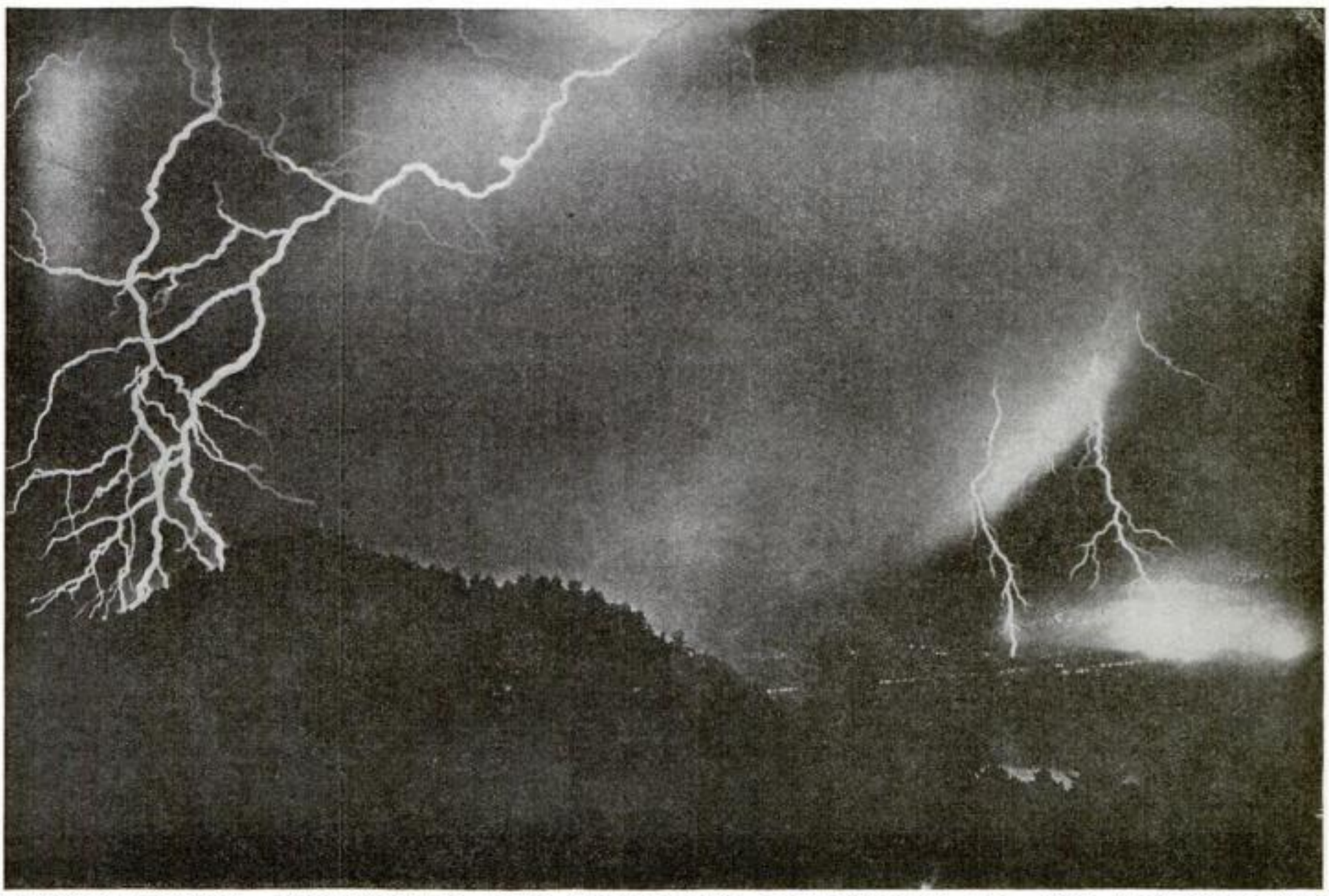
5. According to the latest theories air and every other known substance is made up of protons, which are positive particles of electricity, and electrons which are negative particles. Since all substances are made of nothing but electricity, there can be no air without electricity. However, in normal air, the electrical charges of which it is composed are in a state of balance, so no outward electrical manifestations are apparent except when produced by weather conditions.

6. The function of the insulation on an electric wire is to keep the wire from touching any other conductor of electricity. If the wires in your home were so strung that it would be impossible to touch them with your hands and so fixed that they could not sag against each other or touch anything, there would be no need of any insulation.

7. Since nobody knows what electricity actually is, it is impossible to define the distinction between positive and negative electricity. All we know with any certainty is that there seem to be two kinds of electric charge. The electronic theory of positive protons surrounded by rapidly whirling negative electrons seems to fit in with more of the observed facts about electricity than any other theory advanced up to the present time.

8. Pure silver is the best conductor of electricity. Pure copper runs it a close second. All metals are relatively much better conductors than nonmetallic elements. Size for size, aluminum wire is not as good a conductor as copper or silver, but if you compare the conductivity of a piece of silver or copper wire with the conductivity of a piece of aluminum wire of the same weight and length, you will find that the aluminum wire is the better conductor. This is because it is so much lighter than copper or silver that a much larger wire can be used.

WHAT WESTINGHOUSE IS DOING IN RESEARCH



WESTINGHOUSE ENGINEERS ARE STUDYING LIGHTNING IN ITS STRONGHOLD

Waging War Against Lightning

Lightning, the raider of power lines, each year exacts a heavy toll in lost time and damaged equipment. In the flick of an eyelash, or less, it stages its attack, vanishes, and leaves no trace except a trail of waste and ruin which must promptly be repaired to maintain standards of service.

Long ago Westinghouse declared war against this elusive plunderer when A. J. Wurts, a Westinghouse engineer, developed his famous lightning arrester.

Now science has placed in the hands of engineers new devices for repelling this invader.

Today, in the mountains of Tennessee, Westinghouse has established an outpost of engineers armed with amazing new machines swifter than lightning itself to gather records to serve as foundations for protective devices.

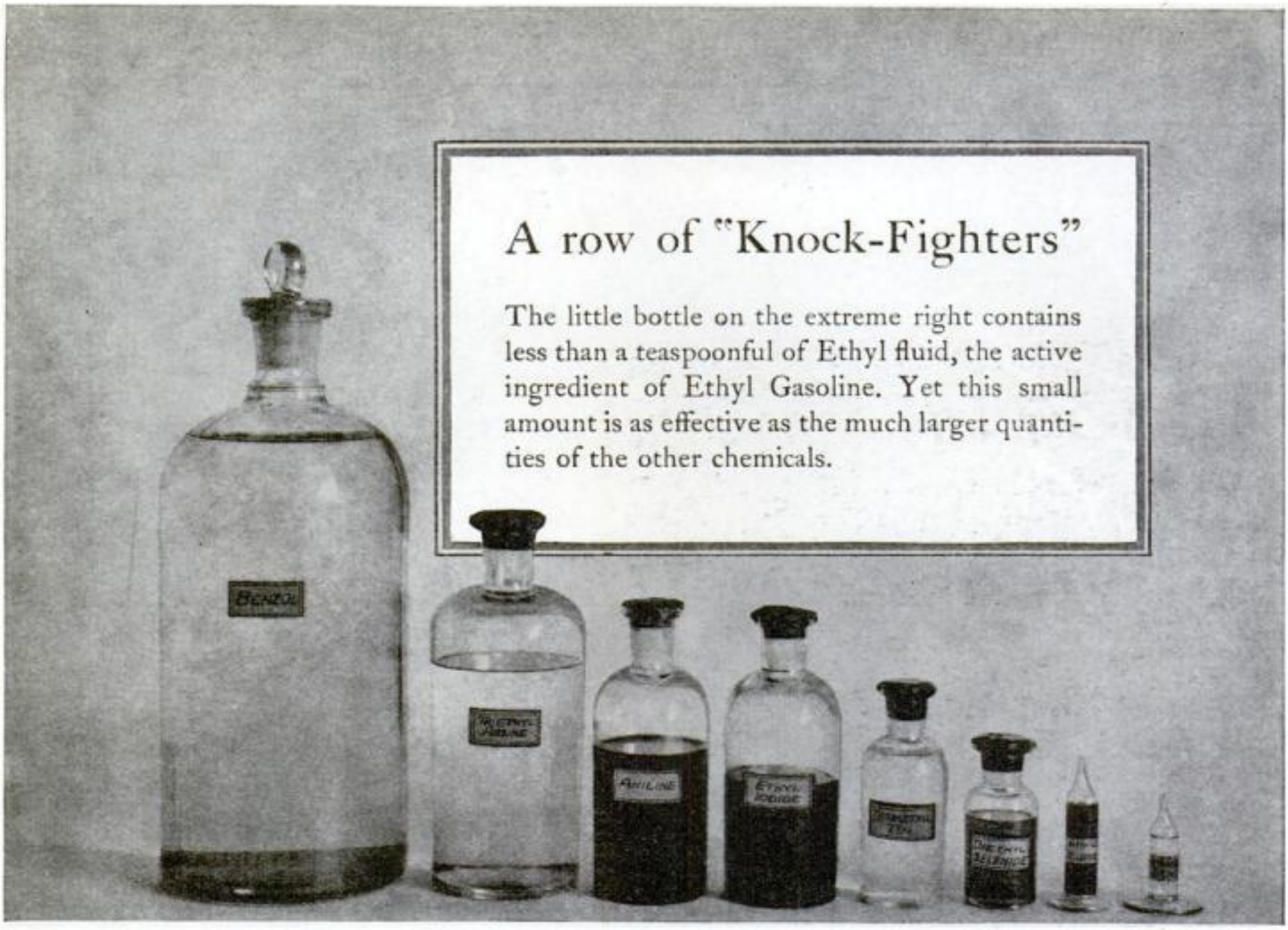
The new Norinder oscillograph catches the flash of any lightning stroke within its range. The smallest spark or the hundred-million-volt explosion leaves its autograph for experts to study and compare. Along with this device sensitive Osisos record line disturbances and indicate the position and magnitude of thunderbolts. Klydonographs record the shocks received by transmission lines. Every important detail is observed and reported.

Thus Westinghouse, pioneer in the development of practical methods of generating and transmitting alternating current, is now developing new ways to protect power transmission . . . a basic asset to the world of business and industry.

The Sign of a Westinghouse Dealer

Westinghouse Electrification Appliances Apparatus Wiring W

Westinghouse



The Steps to High Compression Performance

THOUSANDS of chemical combinations were tested in the General Motors Research Laboratories to see whether they would eliminate the fuel "knock" in gasoline engines which was retarding the advancement of high compression engines. In the picture above are a few of the compounds that had anti-knock value. They illustrate the gradual progress toward more and more effective elimination of the "knock."

The little bottle on the right contains Ethyl fluid which is the active ingredient in Ethyl Gasoline. It is the most effective of them all. The amount in the little bottle is equivalent in anti-knock value to the amount of other chemicals contained in the larger bottles.

It is so effective that even a teaspoonful added to a gallon of gasoline makes Ethyl Gasoline—the standard high compression fuel which has made possible the new high compression cars. And it also brings out the maximum performance of which cars of average compression are capable.

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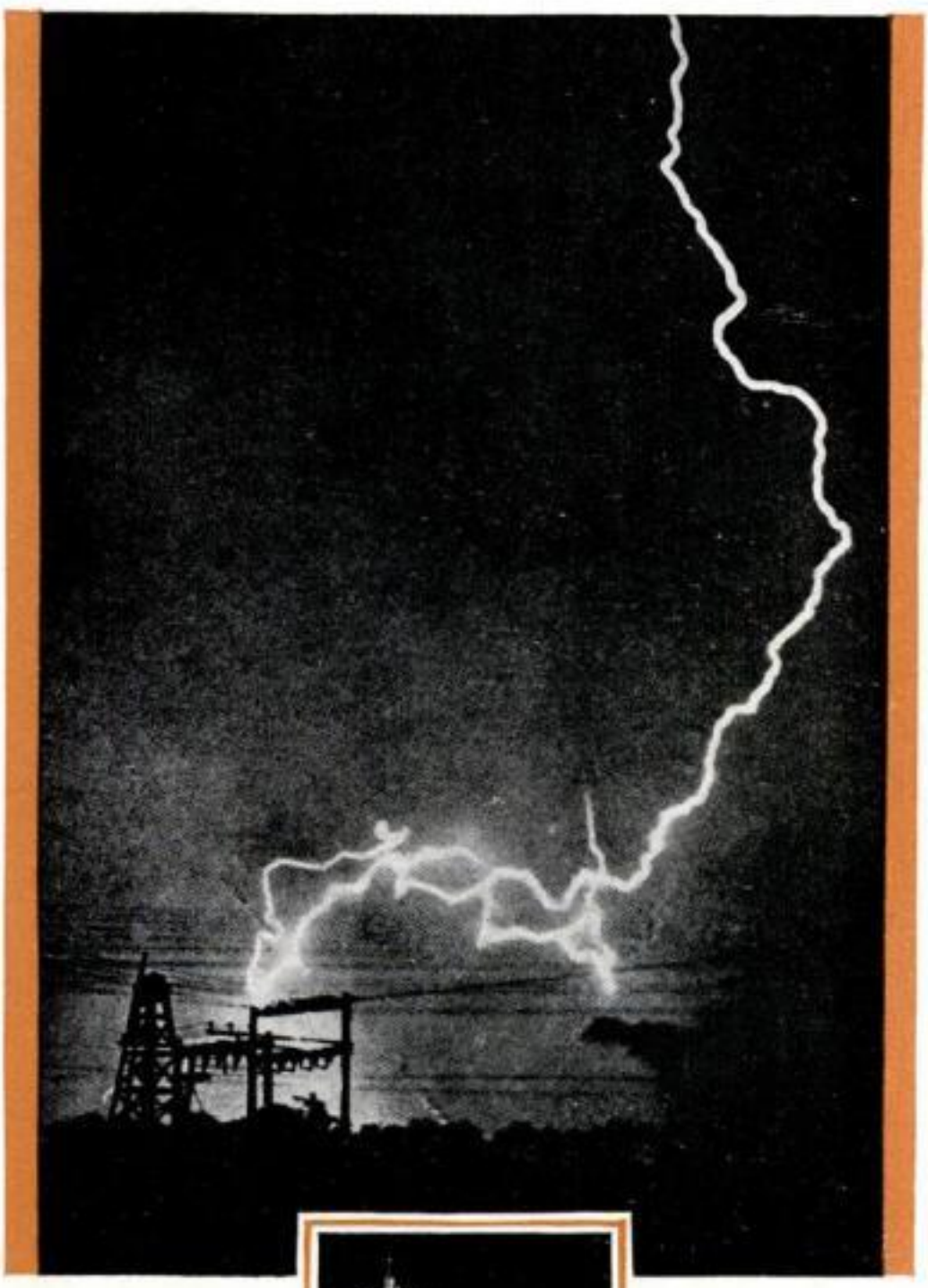
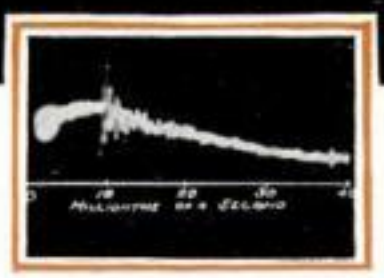
Man's hand upon the Lightning



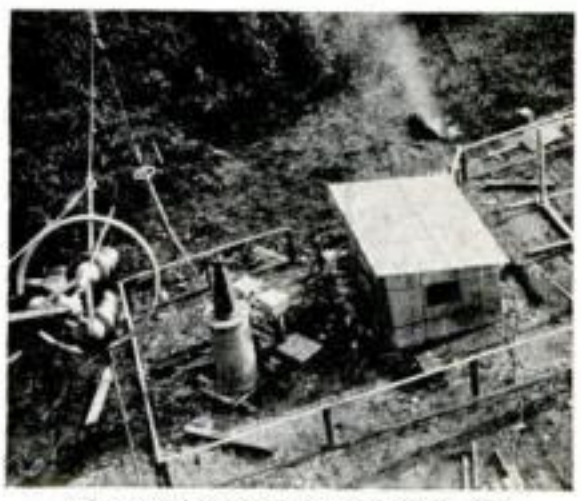


The cathode-ray oscillogram of the induced lightning surge.

NOT yet is the lightning tamed. But the hand of science reaches forth. Already a way has been found to make the lightning write its own record of this destructive force measured in millions of horsepower, which is still the greatest enemy of high-voltage transmission lines.

One such record is reproduced on this page. It was taken on the lines of the Pennsylvania Power and Light System by a cathode-ray oscillograph — a high-speed camera developed in the General Electric laboratories. The surge that was recorded measured 2,500,000 volts; the record showed that the lightning lasted 40 millionths of a second.

Before science can control natural forces it must first develop data and measurements. Ultimately out of this comes control. Fundamental research of this kind seldom brings immediate financial return. Its ultimate value, both to the electrical industry and to the public, is beyond price.



The special field laboratory which was used for the epoch-making experiment.

Back of every product bearing the G-E monogram, from an electric locomotive to the tiny motor that runs a sewing machine, is the basic scientific research for which the General Electric laboratories are famous. Both in the home and in industry this monogram carries the same assurance of electrical correctness and dependability.

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